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Water Movement Through Saturated-Unsaturated Porous Media: a Finite-Element Galerkin Model

M. Reeves
J. O. Duguid

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M. Reeves
Computer Sciences Division

J. O. Duguid
Environmental Sciences Division

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OAK RIDGE NATIONAL LABORATORY
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ABSTRACT

A two-dimensional transient model for flow through saturated-unsaturated porous media has been developed. This model numerically solves the governing partial differential equations, which are highly nonlinear. The model code uses quadrilateral finite elements for the geometrical assembly, bilinear Galerkin interpolation for the spatial integration, and Gaussian elimination for the solution of the resulting matrix equations. In addition to the usual constant-flux and constant-head boundary conditions, the code is capable of applying pressure-dependent boundary conditions at the ground surface. Thus, infiltration into or seepage from this surface may be simulated. Each element may be assigned different material properties that allow the investigation of layered geologic formations.

The formulation of the governing equations and the computer implementation are presented. The report is intended for use as a complete user's manual and contains a listing of the computer code (in FORTRAN) along with both input and output data for two example problems.

The results of a computer simulation are compared with experimental data obtained by J. D. Hewlett and A. R. Hibbert from an inclined soil slab at Coweeta Hydrologic Laboratory in North Carolina. The computer model gives good results in this simulation.

The Galerkin finite-element method is found to be superior to the finite-difference method used by previous investigators. Here a comparison with a finite-difference model developed by R. A. Freeze is made. By exploiting the flexibility of the finite-element geometrical discretization, the user may easily reduce computer running time by a factor of two.

I. INTRODUCTION

The equations governing the movement of moisture through saturated-unsaturated media may be formulated in the most general form when the flow of both air and water is considered. The coupled set of equations in the unsaturated region can then be treated by multiple-phase flow techniques. This approach was carried out by Green et al. (1970) and by Van Phuc and Morel-Seytoux (1972). Here the advantage is that the equation for air movement allows for the extreme drying of the unsaturated zone that is encountered in desert regions (personal communication with S. P. Neuman, Institute of Soils and Water Agricultural Research Organization, Bet Dagan, India). The disadvantage of such a formulation is that in a large basin-oriented model the added computational complexity drastically restricts the size of the region that may be modeled.

In an effort to develop a simpler model that gives good results in many flow problems, soil physicists have formulated a single equation in terms of fluid pressure. This equation is valid where the combined air-water system can be treated as a single phase (i.e., air pockets do not develop within the medium). Transient two-dimensional models that are based on this equation for saturated-unsaturated flow were pioneered by Rubin (1968). His paper was followed by other two-dimensional applications: Hornberger et al. (1969), Taylor and Luthin (1969), and Verma and Brutsaert (1970). These studies used Laplace's equation in the saturated zone and therefore were limited to near-surface flow in homogeneous, incompressible, and unconfined aquifers. Cooley (1970) studies pumping from an unconfined system using a form of the more general equation that was presented by Freeze (1971a).

A series of papers by Freeze (1971a-1972c) presents the formulation of a model using a more general form of the equation for transient flow through saturated-unsaturated porcus media. This equation includes the compressibility of the medium and the compressibility of the fluid, and applies to either confined or unconfined inhomogeneous aquifers. Freeze's computer model is capable of solving transient problems in either two- or three-dimensional regions with a wide range of surface boundary conditions. Here it must be pointed out that a transient three-dimensional model has a large core storage requirement and is thus limited to small regions.

All of the computer models discussed previously use the finite-difference method to solve the governing flow equation numerically. The parameters of the governing equation as well as the boundary conditions are highly nonlinear functions of the dependent variable. Because of this strong nonlinearity, attempts to solve problems using the finite-difference method were never entirely successful. The numerical instabilities encountered in the solution can only be minimized by reduction of both element size and time increment. These reductions increase the computer core and time necessary for a given simulation. However, Verma and Brutsaert (1970) found that the solution converges faster when Gauss elimination is used for the solution of the resulting matrix equations than when other less implicit iterative procedures are used.

Because of the numerical instability encountered and the difficulty in fitting elements to irregular regions using the finite-difference method, we decided to investigate the possibility of using the Galerkin finite-element method. We had found in earlier unpublished work that numerical instability was decreased by Galerkin integration but did not completely disappear. Neuman (1974) has also demonstrated that the Galerkin finite-element method gives more stable solution to the governing equations. Because of the increased stability, element size and time increment can be increased. The increases reduce the computer core and time necessary for a given simulation while maintaining a realistic degree of accuracy in the solution. Conversely, the finite-element approach allows the solution of the governing equation over a larger region. Another advantage of this method is that irregular region boundaries can be treated in a more realistic manner (i.e., a sloping boundary can be considered).

The purpose of developing a new two-dimensional transient model was twofold: (1) to allow an investigator to study the moisture movement through saturated-unsaturated porous media; and (2) to provide the transient fluid velocities necessary for the solution of material transport problems. The authors (Duguid and Reeves, 1974) have developed a computer model to simulate transport of dissolved materials. In addition to advection arising from the Darcy velocity, this model includes effects of dispersion, adsorption, and radioactive decay.

In investigations of the movement of fluid through a porous region, the model must have the capability of applying general boundary conditions. The model developed in this study has the capability of using such boundary conditions as constant seepage, seepage arising from precipitation, and the development of seepage surfaces. The combination of these boundary conditions allows the investigation of problems that arise in nature.

The use of a compartmental model or a model that does not solve the governing physical equation will not generate the detailed velocity information required for solution of mass transport problems. The fluid velocity output from the model described in this report can be used as input to a second model which considers material transport. Here the user must be cautioned because the velocities from this code are discontinuous. The discontinuities in velocity are a problem when the advection term of the material transport equation is large. In other words, continuity is not satisfied when the coefficient of diffusion is small (personal communication with George Pinder, Princeton University, Princeton, New Jersey). This problem can be eliminated by obtaining the velocities by direct solution of a coupled set of equations. This increases the computer core required because the dependent variables increase in number from one to three. Because of the generality of the Galerkin finite-element method, the code may be easily modified when this problem is encountered.

To use the code described in this report requires a rather extensive data base. Geometrically the region to be considered must be defined. Such information as surface elevations, bed-rock depths, soil-water divides, soil horizon depths and thicknesses, and geological stratification is required. Soil properties are necessary. In the saturated regions conductivity and medium compressibility are needed for each formation. In the unsaturated regions curves of conductivity vs. pressure and of water content vs. pressure for each soil type are required. It is, of course, most desirable to have experimental measurements taken from the region to be considered. However, values reported in the literature for similar soils may be substituted as required. Finally, boundary conditions, precipitation rate as a function of time, stream depths, and depth of water in seepage pit, for example, must be specified. The large quantity of input information required by a physics-based model such as ours is cumbersome. However, for situations of potentially substantial pollution of surface and ground waters, the authors know of no viable alternative.

II. THEORETICAL DEVELOPMENT

The approach used in this study employs a single equation that considers only the flow of water. The air phase has been assumed to be continuous and is at atmospheric pressure; therefore, there can be no entrapped pockets of compressible air in the flow system. This assumption could prove to be a serious limitation in some applications, but it has been universally and apparently successfully used by soil physicists in the solution of irrigation and drainage problems (Freeze, 1971).

1. Formulation of Flow Equation. The equations governing flow in saturated-unsaturated porous media consist of an equation of (1) continuity of the fluid, (2) continuity of the solid, (3) motion of the fluid, (4) consolidation for the medium, and (5) state for the compressibility of water. These equations will be combined to form one governing equation for flow through porous media.

For a complete formulation of the continuity equations, the reader is referred to Cooper (1966) and Duguid and Lee (1973). Continuity of the fluid is expressed as:

$$\frac{\partial(S\rho_f n)}{\partial t} + \nabla\cdot\rho_f n S\overline{V}_s + \nabla\cdot\rho_f\overline{V}_{fs} = 0 \qquad (1)$$

where n is porosity, S is saturation, ρ_f is fluid density, $\overline{V}_s$ is velocity of the solid, and $\overline{V}_{fs}$ is velocity of the fluid relative to the solid. Here the term velocity has been used interchangeably with Darcian flux of fluid relative to solid. The granular skeleton of the medium is considered to be compressible, but the grains themselves are considered to be incompressible. The continuity equation for incompressible solids is

$$\frac{\partial(1-n)}{\partial t} + \nabla\cdot(1-n)\,\overline{V}_s = 0 \qquad (2)$$

where the term (1-n) represents the volume concentration of the solids.

The equation of motion of the fluid is Darcy's law for an anisotropic medium and is written in the form

$$\overline{V}_{fs} = -\overline{\overline{K}}\cdot\nabla H \qquad (3)$$

where H is the hydraulic head and $\overline{\overline{K}}$ is the hydraulic conductivity tensor. Hydraulic conductivity is defined as

$$\overline{\overline{K}} = \frac{\overline{\overline{k}}\rho_f g}{\mu_f} \qquad (4)$$

where g is the acceleration of gravity μ_f is the fluid viscosity, and $\overline{\overline{k}}$ is the intrinsic permeability tensor. The existence of a continuous saturated-unsaturated flow domain implies the existence of a corresponding potential field, which is defined by DeWiest (1965) as

$$\Gamma = g\int_{z_0}^{z} dz + \int_{p_0}^{p} \frac{dp}{\rho_f} \qquad (5)$$

which, in this case, yields

$$\Gamma = gH = g\left(z + \frac{p - p_0}{\rho_f g}\right) \qquad (6)$$

where p is the pressure, z is the elevation, and z_o is an arbitrary datum at which the pressure is p_o. The term Γ is Hubbert's force potential. The total hydraulic head may be written

$$H = z + h \tag{7}$$

where the pressure head h is

$$h = \frac{p - p_o}{\rho_f g} = \frac{\sigma}{\rho_f g} \tag{8}$$

with σ representing the incremental pressure in the fluid. The substitution of Eq. (7) into Darcy's law, Eq. (3), yields the equation of motion

$$\overline{V}_{fs} = -\overline{\overline{K}}\cdot(\nabla h + \nabla z) \tag{9}$$

The three-dimensional consolidation equation developed by Biot (1940) is

$$(\lambda_s + 2\mu_s)\,\nabla^2 e = \nabla^2 \sigma \tag{10}$$

where λ_s and μ_s are Lamé constants for the medium and e is the dilatation of the medium. The dilatation is defined as

$$e = \epsilon_{kk} \tag{11}$$

where ε_{ij} is the strain tensor.

The equation of state for the fluid compressibility is

$$\rho_f = \rho_f^0 \, e^{\beta(p-p_0)} = \rho_f^0 \, e^{\beta' h} \tag{12}$$

where β is the coefficient of compressibility of the fluid. The term β' is the modified coefficient of compressibility of water:

$$\beta' = \beta \rho_f g \tag{13}$$

Before continuing the formulation of the flow equation, several functional relations should be noted. The fluid density is a function of pressure head, as is indicated by Eq. (12). The hydraulic conductivity is a function of both position and pressure head

$$\bar{\bar{K}} = \bar{\bar{K}}(\bar{x},h) \tag{14}$$

where $\bar{x}$ is a position vector. In saturated regions the variability of conductivity with space is due only to inhomogeneity of the medium. In unsaturated regions $\bar{\bar{K}}$ is a function of position and time even in homogeneous soils because of its dependence on pressure head. Porosity is a function of both position and pressure head

$$n = n(\bar{x},h) \tag{15}$$

because the pore size is governed by the consolidation equation. The volumetric moisture content θ may be defined in terms of saturation and porosity as

$$\theta(\bar{x},h) = S(\bar{x},h)\, n(\bar{x},h) \tag{16}$$

Thus, as the medium becomes completely saturated, the moisture content approaches the value of the porosity of the medium.

When Eq. (1) is written in its expanded form and Eq. (2) is expanded and substituted into Eq. (1), the following result is obtained:

$$\rho_f\, n \frac{\partial S}{\partial t} + nS \frac{\partial \rho_f}{\partial t} + S\rho_f \nabla\cdot\bar{V}_s + \nabla\cdot\rho_f\bar{V}_{fs} + n\bar{V}_s\cdot\nabla(\rho_f S) = 0 \tag{17}$$

where the last term of Eq. (17) may be neglected as a higher-order effect. From the equation of motion, Eq. (9), it follows that

$$\nabla\cdot(\rho_f\bar{V}_{fs}) = -\nabla\cdot[\rho_f\bar{\bar{K}}\cdot(\nabla h + \nabla z)] \tag{18}$$

and substitution of this expression into Eq. (17) yields

$$\rho_f n \frac{\partial S}{\partial t} + Sn \frac{\partial \rho_f}{\partial t} + S\rho_f \nabla\cdot\bar{V}_s = \nabla\cdot[\rho_f\bar{\bar{K}}\cdot(\nabla h + \nabla z)] \tag{19}$$

The specific moisture capacity is

$$\frac{d\theta}{dh} = n \frac{\partial S}{\partial h} \tag{20}$$

from which it follows that

$$\frac{d\theta}{dh}\frac{\partial h}{\partial t} = n\frac{\partial S}{\partial t} \tag{21}$$

From the equation of state, Eq. (12), the expression

$$\frac{\partial \rho_f}{\partial t} = \rho_f \beta' \frac{\partial h}{\partial t} \tag{22}$$

is obtained.

When both sides of the three-dimensional consolidation equation, Eq. (10), are integrated, the following expression results:

$$(\lambda_s + 2\mu_s)e = \sigma + f \tag{23}$$

where the function f is a function of both position and time and must satisfy Laplace's equation $\nabla^2 f = 0$ for all time. Verruijt (1969) shows that if all of the displacement u is assumed to be vertical, i.e., $\bar{u} = u_z z$, then the function f is zero. It follows that

$$\frac{\partial e}{\partial t} = \alpha \frac{\partial \sigma}{\partial t} \tag{24}$$

where

$$\alpha = \frac{1}{(\lambda_s + 2\mu_s)}$$

and α is the coefficient of consolidation of the medium. When the definitions

$$e = \nabla \cdot \bar{u} \quad \text{and} \quad \bar{V}_s = \frac{\partial \bar{u}}{\partial t} \tag{25}$$

and the definition of pressure head, Eq. (8), are used in conjunction with Eq. (23), we obtain

$$\nabla \cdot \overline{V}_s = \frac{\partial e}{\partial t} = \alpha \rho_f g \frac{\partial h}{\partial t} = \alpha' \frac{\partial h}{\partial t} \tag{26}$$

where

$$\alpha' = \alpha \rho_f g \tag{27}$$

is the modified coefficient of compressibility of the medium.

When the terms defined by Eqs. (16), (21), (22), and (26) are substituted into Eq. (19), the following is obtained:

$$\left[\frac{\theta}{n}\alpha' + \theta\beta' + \frac{d\theta}{dh}\right] \frac{\partial h}{\partial t} = \nabla \cdot [\overline{\overline{K}} \cdot (\nabla h + \nabla z)] \tag{28}$$

Equation (28) reduces to the elastic storage equation if the aquifer is assumed to be saturated. For unsaturated flow it reduces to what soil physicists commonly refer to as Richard's equation. Thus, Eq. (28) is valid for both saturated and unsaturated flow. When a generalized storage constant is defined as

$$F = \frac{\theta}{n}\alpha' + \theta\beta' + \frac{d\theta}{dh} \tag{29}$$

Eq. (28) may be rewritten as

$$F \frac{\partial h}{\partial t} = \nabla \cdot \overline{\overline{K}} \cdot (\nabla h + \nabla z) \tag{30}$$

The corresponding equation for the total head, Eq. (7), is

$$F \frac{\partial H}{\partial t} = \nabla \cdot \overline{\overline{K}} \cdot \nabla H \tag{31}$$

Both Eqs. (30) and (31) are, in general, nonlinear since the soil properties F and $\bar{\bar{K}}$ depend on pressure head h.

2. Spatial Integration by the Galerkin Finite Element Method. The method used in the spatial integration of Eq. (30) is a special case of the broad category called weighted-residual methods. These methods, in their classical form, approximate the solution to the differential equations and satisfy the boundary conditions exactly. In the differential equation

$$L(\Phi) = 0 \qquad (32)$$

L is a differential operator and Φ is the dependent variable. The weighted-residual approximate solution Φ' over the region V is obtained from the equation

$$\int_V W_j \, L(\Phi') dV = 0 \qquad (33)$$

The W_j comprise a set of weighting functions, and Φ', the trial solution, has the form

$$\Phi' = \sum_{i=1}^{m} N_i \, \phi_i \qquad (34)$$

where the N_i are trial functions, the ϕ_i are unknown amplitudes of the trial solutions, and $L(\phi') \neq 0$ is the residual. The special case in which the weighting functions W_j are chosen as the trial functions N_i is the Galerkin method. In effect, the equations for the Galerkin method

$$\int_V N_j \, L\left(\sum_{i=1}^{m} N_i \, \phi_i \right) dV = 0 \qquad j = 1(1)\,N \qquad (35)$$

require that the residual of the differential equation is made orthogonal to each term in the trial series. As m becomes large, Φ' approaches Φ. Coefficients ϕ_i may be obtained by integration and solution of the above equations, and the approximate solution Φ' is obtained by substituting these coefficients into the trial solution summation (Finlayson, 1972).

In the classical Galerkin method, each of the trial solutions N extends over the entire domain V and must satisfy all boundary conditions. Hence the method is restricted to simply shaped, simply connected regions with homogeneous material properties. However, the power and generality of the Galerkin method can be extended considerably by combining it with a finite element discretization in which the region of integration is represented by an assemblage of subdomains. In two-dimensional space these elements would be polygons and in three-dimensional space they would be polyhedra. These subdomains are called elements, and their corners, or connection points, are called nodes. In this approach, the family of trial solutions consists of subfamilies of very simple functions. The ϕ_i satisfy the boundary conditions, and not the basis function N_i, which are nonzero on only one of the subdomains. The coefficients ϕ_i become the amplitudes of the unknown function at the nodes. This finite-element approach, in effect, is a piecewise Galerkin approximation which permits the application of the Galerkin method to complex geometries and non-homogeneous media. A more detailed discussion of the Galerkin finite-element method is given by Hutton and Anderson (1971). The formulation and use of finite-element Galerkin methods in groundwater analysis are presented by Pinder and Frind (1972).

In such a formulation it is convenient to introduce one basis function $\{N(\bar{x})\}$ for each element r. This one combination weighting-trial function is, however, a column vector that has a separate $N_i(\bar{x})$ for each node i of the element. Each of these functions is bilinear and extends across the entire element. Each has a magnitude of unity at node i and a magnitude of zero at all other nodes. Because of the latter property, coefficients ${}_rh_i$ of the trial solution

$$ {}_r\Phi' = {}_rh(\bar{x},t) = \{N(\bar{x})\}^T \{{}_rh(t)\} \tag{36}$$

are identical to the total head at each node as anticipated by the new notation for expansion of the coefficients ϕ_i on the right-hand side of Eq. (36).

When Galerkin's method is applied to Eq. (30) in the r-th element, the equations are

$$\int_{{}_rV} \{N\} [F_r\dot{h} - \nabla\cdot\bar{\bar{K}}\cdot(\nabla_r h + \nabla_r z)]\, d_rV = 0 \tag{37}$$

where ${}_r\dot{h} = d_rh/dt$. Green's theorem,

$$\int_V \psi_1 \nabla\cdot\nabla\psi_2 \, dV = \int_S \bar{n}\cdot\psi_1 \nabla\psi_2 \, dS - \int_V \nabla\psi_1 \nabla\psi_2 \, dV \tag{38}$$

in terms of general functions ψ_1 and ψ_2, may be applied to the second-derivative terms of Eq. (37) to yield

$$\int_{{}_rV} [\{N\}F_r\dot{h} + \nabla\{N\}\cdot\bar{\bar{K}}\cdot(\nabla_r h + \nabla_r z)]\, d_rV + \int_{{}_rS} \bar{n}\cdot\{N\}[-\bar{\bar{K}}\cdot(\nabla_r h + \nabla_r z)]\, d_rS = 0 \tag{39}$$

where $\bar{n}$ is an outwardly directed unit vector which is normal to the surface $_rS$. The term in square brackets under the surface integral is the Darcy flux $\bar{V}_{fs}$, Eq. (9), and the weighted-residual integral becomes

$$\int_{_rV} [\{N\}F_r\dot{h} + \nabla\{N\}\cdot\bar{\bar{K}}\cdot(\nabla_r h + \nabla_r z)]\, d_rV + \{_rR'\} = 0 \tag{40}$$

where

$$\{_rR'\} = \int_{_rS} \{N\}\bar{n}\cdot\bar{V}_{fs}\, d_rS \tag{41}$$

The last integral simply apportions the moisture per unit time flowing out of the r-th element to the element nodes.

When the trial function, Eq. (36), is combined with the Galerkin integral, Eq. (40),

$$\int_{_rV} (\{N\}F\{N\}^T\{_r\dot{h}\} + \nabla\{N\}\cdot\bar{\bar{K}}\cdot\nabla\{N\}^T\{_rh\} + \nabla\{N\}\cdot\bar{\bar{K}}\cdot\nabla_r z)\, d_rV + \{_rR'\} = 0 \tag{42}$$

After element matrices

$$[_rA] = \int_{_rV} \{N\}F\{N\}^T\, d_rV \tag{43}$$

$$[_rB] = \int_{_rV} \nabla\{N\}\cdot\bar{\bar{K}}\cdot\nabla\{N\}^T\, d_rV \tag{44}$$

and

$$\{_rD\} = \int_{_rV} \nabla\{N\}\cdot\bar{\bar{K}}\cdot\nabla_r z\, d_rV \tag{45}$$

are defined, Eq. (42) may be rewritten in the simplified form

$$[{}_rA]\{{}_r\dot{h}\} + [{}_rB]\{{}_rh\} + \{{}_rR'\} + \{{}_rD\} = 0 \tag{46}$$

3. Time Integration by the Finite-Difference Method. Equation (46) is written for an arbitrary increment of time $\omega\Delta t$:

$$[{}_rA]\{{}_r\dot{h}\}_{t+\omega\Delta t} + [{}_rB]\{{}_rh\}_{t+\omega\Delta t} + \{{}_rR'\} + \{{}_rD\} = 0 \tag{47}$$

In the Crank-Nicholson centered-in-time approach $\omega = 1/2$, and in the backward-difference approximation $\omega = 1$. The Crank-Nicholson algorithm has a truncation error of $O(\Delta t^2)$, but its propagation-of-error characteristics frequently lead to oscillatory instabilities. The backward-difference scheme, on the other hand, has a truncation error of $O(\Delta t)$ but is quite resistant to oscillatory instabilities. An arbitrary ω allows an investigator to find the appropriate balance for the problem being considered.

The time derivative of the pressure head is expressed as

$$\{{}_r\dot{h}\}_{t+\omega\Delta t} \approx (\{{}_rh\}_{t+\Delta t} - \{{}_rh\}_t)/\Delta t \tag{48}$$

and the value of this quantity at the arbitrary point in time is

$$\{{}_rh\}_{t+\omega\Delta t} = \omega\{{}_rh\}_{t+\Delta t} + (1-\omega)\{{}_rh\}_t \tag{49}$$

Substituting Eqs. (48) and (49) into Eq. (47), the following relationships are obtained:

$$[{}_rC^i]\{{}_rh^{i+1}\}_{t+\Delta t} = \{{}_rR^i\} - \{{}_rR'\} \tag{50}$$

where

$$[{}_rC^i] = [{}_rA^i]/\Delta t + \omega[{}_rB^i] \tag{51}$$

and

$$\{{}_rR^i\} = ([{}_rA^i]/\Delta t - (1-\omega)[{}_rB^i])\{{}_rh\}_t - \{{}_rD^i\} \tag{52}$$

It should be understood that matrices $[{}_rA^i]$, $[{}_rB^i]$, $\{{}_rD^i\}$, and, hence $[{}_rC^i]$ and $\{{}_rR^i\}$ are evaluated at time $t + \omega\Delta t$. These quantities are implicit functions of time since they depend on the soil properties which are explicit functions of the pressure head $h_{t+\omega\Delta t}$. Furthermore, $h_{t+\omega\Delta t}$ depends on the undetermined quantity $h_{t+\Delta t}$. Obviously, iteration is required, a fact which is denoted in Eqs. (50)-(52) by an added superscript. Here $i = 0$ denotes evaluation at t rather than the customary $t + \omega\Delta t$ for all other iterations.

4. Numerical Implementation. For a quadrilateral element with four corner nodes, a bilinear polynomial basis function for the j-th node may be written in terms of local normalized coordinates as

$$\{N\} = \frac{1}{4}\{(1 + ss_j)(1 + \tau\tau_j)\} \qquad j = 1(1)4 \tag{53}$$

where s_i and τ_i are the local coordinates of the corner nodes, which are numbered 1 to 4 progressing around the element in a counterclockwise direction (Fig. 1). In the local coordinate system the element is square regardless of the shape of the quadrilateral in global coordinates. The global coordinates at any point within element r are given in terms of local coordinates by the relations

$$\begin{aligned} {}_r x &= \{N\}^T \{{}_r x\} \\ {}_r z &= \{N\}^T \{{}_r z\} \end{aligned} \tag{54}$$

where $\{{}_r x\}$ and $\{{}_r z\}$ are the global coordinates of the nodes and $\{N^T\}$ is the transpose of {N} which depends on the local coordinates s and τ given in Eq. (53). Here the shape function {N} of the coordinate transformation is the same as the basis function; hence, this element formulation is termed <u>isoparametric</u>. The Jacobian for the transformation from global to local coordinates is expressed as

$$[{}_r J] = \begin{bmatrix} \dfrac{\partial_r x}{\partial s} & \dfrac{\partial_r z}{\partial s} \\ \dfrac{\partial_r x}{\partial \tau} & \dfrac{\partial_r z}{\partial \tau} \end{bmatrix} \tag{55}$$

Substitution of Eq. (54) into the determinant of this expression yields

$${}_r J = \mathrm{Det}[{}_r J] = \{{}_r x\}^T \left(\frac{\partial\{N\}}{\partial s} \frac{\partial\{N\}^T}{\partial \tau} - \frac{\partial\{N\}}{\partial \tau} \frac{\partial\{N\}^T}{\partial s} \right) \{{}_r z\} = \{{}_r x\}\ [P]\ \{{}_r z\} \tag{56}$$

where [P] is defined as

$$[P] = \left(\frac{\partial\{N\}}{\partial s} \frac{\partial\{N\}^T}{\partial \tau} - \frac{\partial\{N\}}{\partial \tau} \frac{\partial\{N\}^T}{\partial s} \right) \tag{57}$$

When the expression for {N}, Eq. (53), is used it may be shown that

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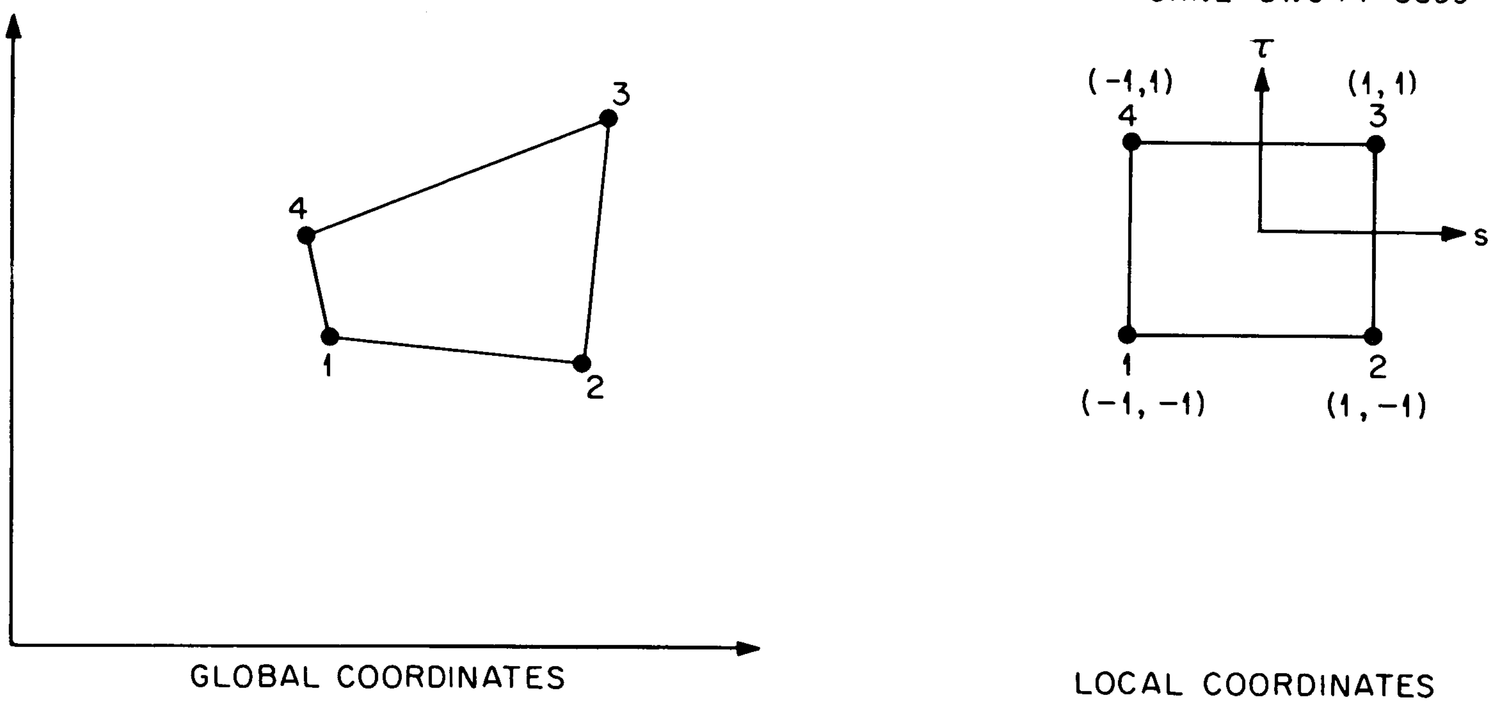

Figure 1. The r-th Finite Element in Global and Local Coordinates.

$$[P] = \begin{bmatrix} 0 & 1-\tau & -s+\tau & -1+s \\ -1+\tau & 0 & 1+s & -s-\tau \\ s-\tau & -1-s & 0 & 1+\tau \\ 1-s & s+\tau & -1-\tau & 0 \end{bmatrix} \tag{58}$$

which is a skew-symmetric matrix. Equations (56) and (58) are combined to yield

$$[P]\{_r z\} = \frac{1}{8}\begin{Bmatrix} z_{24} & -z_{34}s & -z_{23}\tau \\ -z_{13} & +z_{34}s & +z_{14}\tau \\ -z_{24} & +z_{12}s & -z_{14}\tau \\ z_{13} & -z_{12}s & +z_{23}\tau \end{Bmatrix} \tag{59}$$

and the determinant of the Jacobian is

$$_rJ = \frac{1}{8}\{(x_{13}z_{24} - x_{24}z_{13}) + s(x_{34}z_{12} - x_{12}z_{34}) + \tau(x_{23}z_{14} - x_{14}z_{23})\} \tag{60}$$

Terms x_{ij} and z_{ij} are defined as

$$\begin{aligned} x_{ij} &= {_r x_i} - {_r x_j} \\ z_{ij} &= {_r z_i} - {_r z_j} \end{aligned} \tag{61}$$

Equation (60) is used for numerical evaluation of the determinant of the Jacobian.

The integrals of Eqs. (43)-(45) taken over the volume of the r-th finite element may now be written in local coordinates using the determinant of the Jacobian to transform the elemental area:

$$[_rA^i] = \int_{-1}^{1}\int_{-1}^{1} \{N\}F^i\{N\}^T {_rJ}\, ds d\tau \tag{62}$$

$$[{}_rB^i] = \int_{-1}^{1}\int_{-1}^{1} \nabla\{N\}\cdot\bar{\bar{K}}^i\cdot\nabla\{N\}^T {}_rJ\; ds d\tau \tag{63}$$

$$\{{}_rD^i\} = \int_{-1}^{1}\int_{-1}^{1} \nabla\{N\}\cdot\bar{\bar{K}}^i\cdot\nabla_r z_r J\; ds d\tau \tag{64}$$

Integration of these equations is easily carried out using 2 x 2 Gaussian integration. A linear algebraic equation, Eq. (50), results since $\{{}_rh^{i+1}\}$ is a function of time only and the matrices $\{{}_rA^i\}$, $\{{}_rB^i\}$, and $\{{}_rD^i\}$ are evaluated for the previous iteration.

In order to evaluate $[{}_rB^i]$, Eq. (63), expressions for the spatial derivative of the interpolation function are necessary. The chain rule

$$\begin{Bmatrix} \dfrac{\partial}{\partial s} \\ \dfrac{\partial}{\partial \tau} \end{Bmatrix} = [{}_rJ] \begin{Bmatrix} \dfrac{\partial}{\partial_r x} \\ \dfrac{\partial}{\partial_r z} \end{Bmatrix} \tag{65}$$

may be inverted to yield

$$\begin{Bmatrix} \dfrac{\partial}{\partial_r x} \\ \dfrac{\partial}{\partial_r z} \end{Bmatrix} = \frac{1}{{}_rJ} \begin{bmatrix} \dfrac{\partial_r z}{\partial \tau} & -\dfrac{\partial_r z}{\partial s} \\ -\dfrac{\partial_r x}{\partial \tau} & \dfrac{\partial_r x}{\partial s} \end{bmatrix} \begin{Bmatrix} \dfrac{\partial}{\partial s} \\ \dfrac{\partial}{\partial \tau} \end{Bmatrix} \tag{66}$$

using the definition of [J], Eq. (55).

When the top row of Eq. (66) is applied to the basis function {N}, the following is obtained:

$$\frac{\partial\{N\}}{\partial_r x} = \frac{1}{{}_rJ}\left(\frac{\partial\{N\}}{\partial s}\,\frac{\partial\{N\}^T}{\partial \tau} - \frac{\partial\{N\}}{\partial \tau}\,\frac{\partial\{N\}^T}{\partial s}\right)\{{}_rz\} \tag{67}$$

where the transformation equation, Eq. (54), has been used to express z as a function of s and τ. The term enclosed in parentheses is readily identified as [P] from Eq. (57). Thus,

$$\frac{\partial \{N\}}{\partial_r x} = \frac{[P]\{_r z\}}{_r J} \qquad (68)$$

In an entirely analogous way it may also be shown that

$$\frac{\partial \{N\}}{\partial_r z} = \frac{-[P]\{_r x\}}{_r J} \qquad (69)$$

Equations (68) and (69) are in a form suitable for numerical evaluation. These equations and their transposed counterparts are used to evaluate the integrand of $[_r B^i]$, Eq. (63).

5. Assembly of Elements. In order to understand the assembly of the elements that form a system of albegraic equations, a simple example will be used. The example selected is that of a two-dimensional space which is divided into twelve rectangular elements (Fig. 2). Iteration superscripts are dropped for convenience. Both global and local subscripting of the $[_1 C]$ matrix are shown in Fig. 2b. Expansion of matrix $[_1 C]$ into a composite-matrix form is shown in Fig. 3. Assembly consists of summing over the expanded form of each $[_r C]$ to form the composite matrix [C]. The complete [C] matrix will be sparse and banded. The band width may be calculated from the equation

$$\text{IBAND} = 2(\text{MAXDIF}) + 1 \qquad (70)$$

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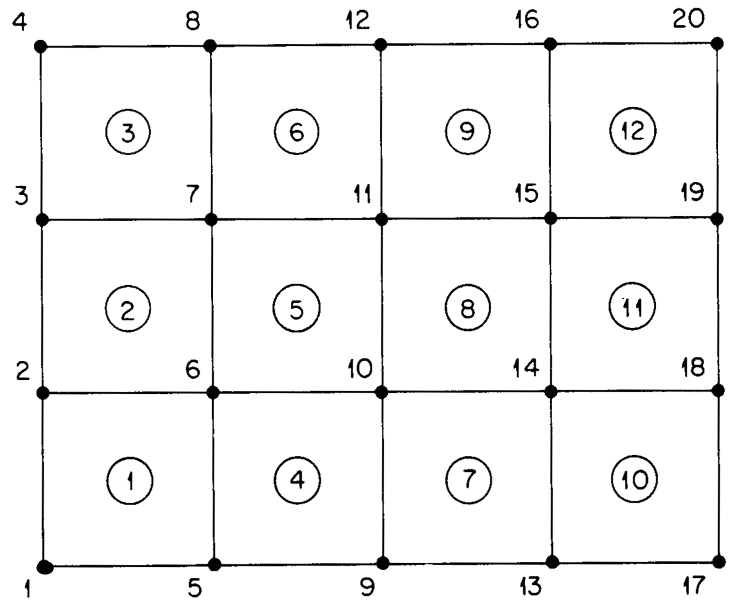

(a)

LOCAL		1	2	3	4
	GLOBAL	1	5	6	2
1	1	C_{11}	C_{12}	C_{13}	C_{14}
2	5	C_{21}	C_{22}	C_{23}	C_{24}
3	6	C_{31}	C_{32}	C_{33}	C_{34}
4	2	C_{41}	C_{42}	C_{43}	C_{44}

(b)

Figure 2. Example Problem. (a) Element representation of the space using global numbering system. (b) Local and global numbering schemes for element-matrix $[_1C]$.

where MAXDIF is the maximum nodal difference in any element of the system and IBAND is the band width. Thus, for the example problem the band width is 11. For more economical use of computer storage, only the band portion need be stored. If the governing equations are symmetric, only the half-band and the diagonal are stored. The most economical form of storage of the banded matrix is shown in the lower portion of Fig. 3. A more detailed discussion of the assembly of finite elements is presented by Desai and Abel (1972).

At this point it is interesting to note that the band width is controlled by the global nodal numbering system. A reduction in computer core storage is achieved by reducing the magnitude of the term MAXDIF. This reduction is obtained by numbering in the direction in which there are the least nodes in a given row or column. If the nodes were numbered in a horizontal direction, the band width would be 13. This represents a significant increase in the core storage required.

Equation (50) is evaluated and assembled for each element, and the assembled system of algebraic equations may be written as

$$[C^i]\{h^{i+1}\}_{t+\Delta t} = \{R^i\} - \{R'\} = \{Y^i\} \tag{71}$$

6. Application of Boundary Conditions. At nodes where Dirichlet (constant) boundary conditions are encountered, an identity equation is generated for each such node and included in the matrices of Eq. (71). As an example, take a one-element system with the pressure at node 1 constrained to the value of b at all times, i.e.,

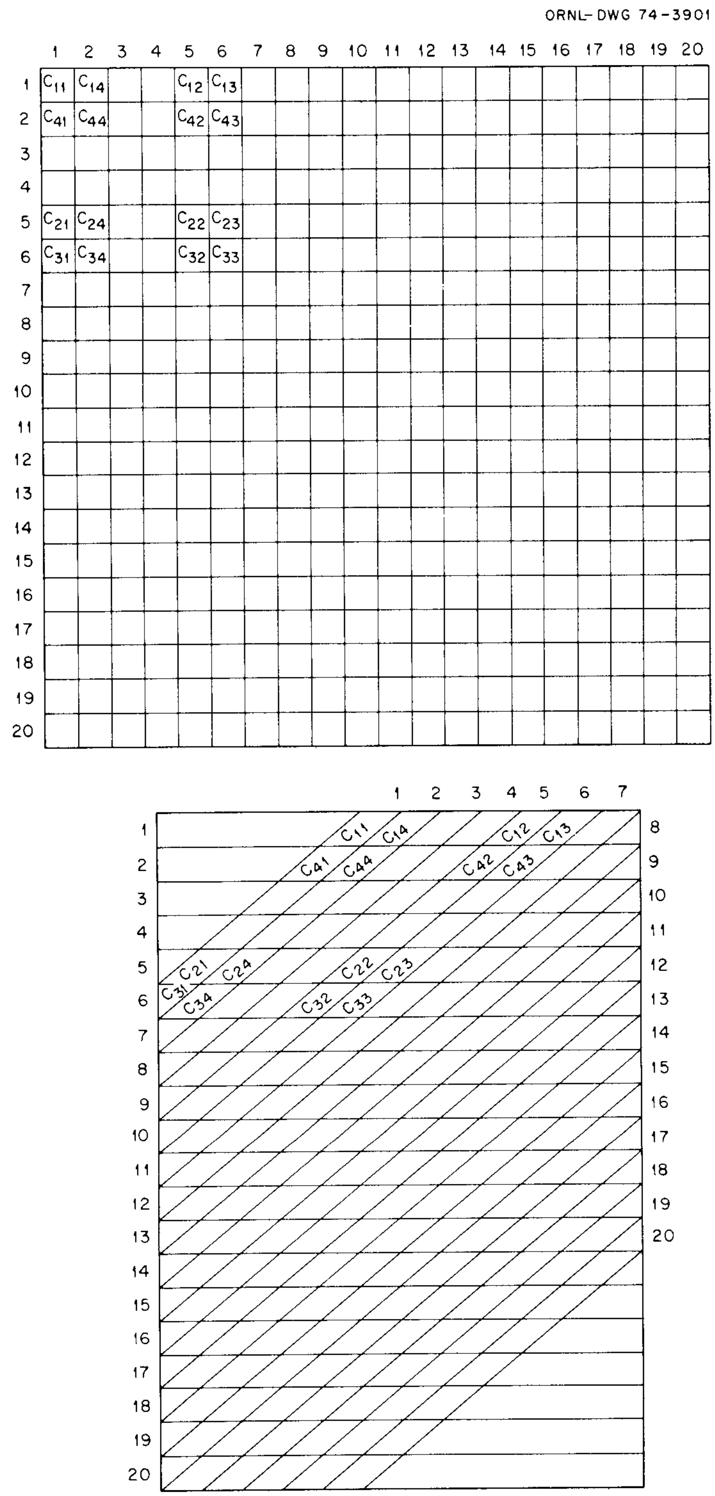

Figure 3. Full and Banded Matrix [C] for the Example Problem.

$$h_1 = b \qquad \text{and} \qquad b \neq b(t) \tag{72}$$

Equation (71) then takes the form

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & C_{22} & C_{23} & C_{24} \\ 0 & C_{32} & C_{33} & C_{34} \\ 0 & C_{42} & C_{43} & C_{44} \end{bmatrix} \begin{Bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \end{Bmatrix} = \begin{Bmatrix} b \\ Y_2 - C_{21}b \\ Y_3 - C_{31}b \\ Y_4 - C_{41}b \end{Bmatrix} \tag{73}$$

This result may easily be generalized to an arbitrary number of equations with an arbitrary number of Dirichlet boundary nodes.

At nodes where Neumann (flux-type) boundary conditions are applied, the surface integral $\{_rR'\}$ in Eq. (41) is formed and assembled over all elements r having surfaces bounding the entire system to yield vector $\{R'\}$. The result is then added to the load vector, as in Eq. (71), at each iteration taken in the solution of a transient problem.

7. <u>Solution of the Assembled Equations</u>. In solving the assembled equations expressed in Eq. (71), the matrix $[C^i]$ is decomposed into the product of upper and lower triangular matrices using the Crout-Dolittle method. The lower triangular matrix is used to modify the right-hand side $\{Y^i\}$ for back-substitution into the upper triangular matrix to obtain a solution. If the matrix $[C^i]$ and the time step Δt do not change with time, then the decomposition needs to be performed only once, and iteration is unnecessary. If, however, the unsaturated soil-moisture zone is considered, such a time-saving device cannot be used and decomposition is necessary for each time step and each iteration.

III. COMPUTER IMPLEMENTATION

The computer program consists of 16 different subroutines (Fig. 4). Their functions are control, primary calculations, support calculations, and input-output operations. Routine MAIN, as its name implies, performs the control function. Perhaps the most important part of the entire calculation is directed by a small section of coding in MAIN (Fig. 5). A soil-properties iteration loop is necessary because the hydraulic conductivity $\bar{\bar{K}}$ and water storage parameter F are dependent upon pressure h, the dependent variable. A pressure dependence in the boundary conditions makes the outer rainfall-seepage cycle necessary. Development of a seepage face or the initiation of rainfall runoff, for example, requires that boundary conditions be changed from a specification of flux to a specification of pressure whenever saturation is reached.

Subroutines Q4, ASEMBL, BC, BANSOL, SPROP, BCPREP, and Q4S perform the primary calculations of the code. In Q4, Jacobians are evaluated and each quadrilateral element is transformed to a local coordinate system where it becomes a square of side length 2. In this system the linear Galerkin basis functions of Eq. (53) and their derivatives are generated, and a 2 x 2 Gauss quadrature is employed to yield element matrices $[{}_rA^i]$, $[{}_rB^i]$, and $\{{}_rD^i\}$ defined in Eqs. (62)-(64). Routine ASEMBL then applies a time-integration algorithm, adjusts subscripts, and sums over elements r to obtain the global matrices $[C^i]$ and $\{R^i\}$, Eqs. (51), (52), and (71). Since the matrix $[C^i]$ is symmetric, only its upper half-band and the diagonal are retained in order to minimize core storage requirements.

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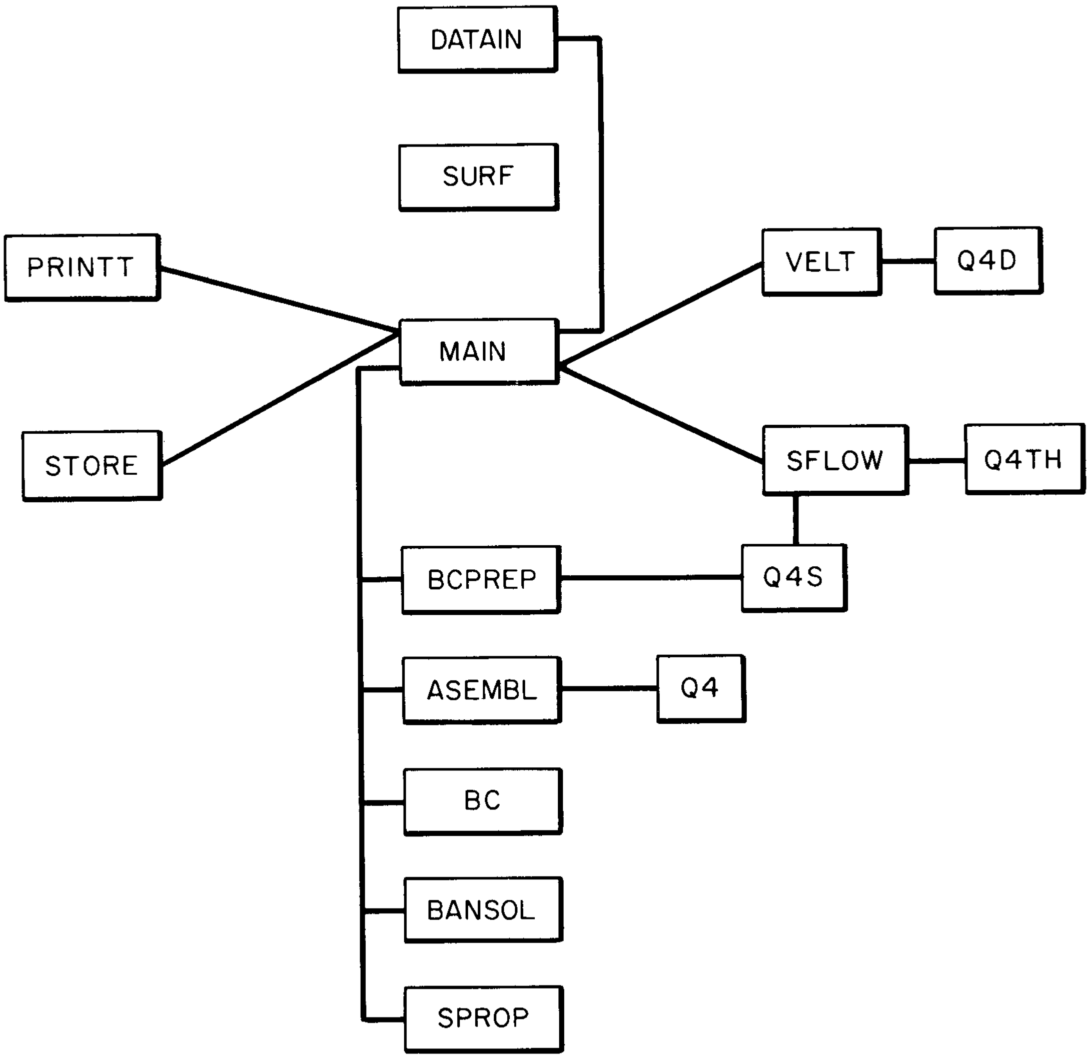

Figure 4. Flow Chart of Moisture-Transport Program.

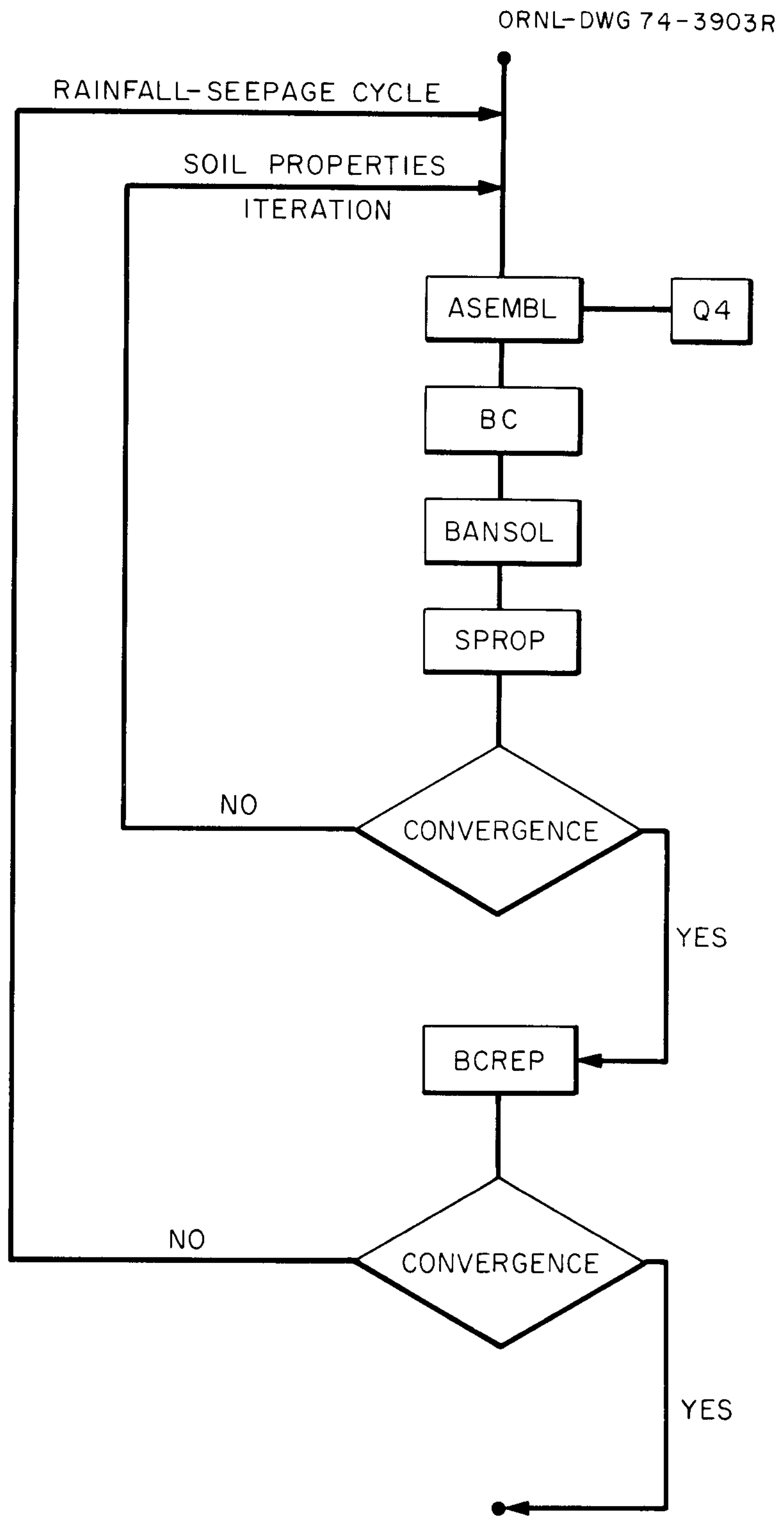

Figure 5. Soil-Properties and Rainfall-Seepage Iteration Loops.

Coefficient matrix $[C^i]$ and load vector $\{R^i\}$ are then appropriately modified to incorporate both Neumann and Dirichlet boundary conditions using subroutine BC. Vector $\{R^i\}$ must be modified only by the additive term $\{R'\}$, Eq. (71), for Neumann conditions, but both $[C^i]$ and $\{Y^i\}$ must be changed for Dirichlet conditions, as shown by means of an example in Eqs. (72) and (73). Routine BANSOL solves the banded matrix equation, Eq. (71), for the pressure heads $\{h^{i+1}\}$ by decomposition into lower and upper triangular matrices and by forward and backward solution of the resulting two matrix equations.

Subroutine SPROP produces the pressure-dependent soil properties $\bar{\bar{K}}$, F, and θ. SPROP must be modified to be consistent with the available data on the soils being considered. These properties may be in the form of tabular data suitable for interpolation, they may be represented by analytical expressions, or they may have a mixture of the two forms. The input data format for soil properties in DATAIN, however, should be general enough to handle all conceivable cases.

Subroutine BCPREP requires more elaboration than the other routines. Basically a group of nodes is specified as rainfall-seepage nodes by the program input (see Appendix E). They are specified in terms of curves (or profiles), rainfall rates vs. time, maximum ponding depths, and the element sides which connect them. The boundary conditions on these nodes are then free to switch from Dirichlet to Neumann conditions depending on values of the pressure or moisture flux.

If, for example, the soil is sufficiently dry at the beginning of a rainfall event, all of the incident moisture can be imbibed by the soil.

A Neumann flux condition is then appropriate since the flux is equal to the incident rainfall rate. If the rainfall continues at a sufficient rate, ponding will eventually commence and continue until the maximum ponding depth is reached. It is then necessary to change to a Dirichlet condition where surface pressure is simply the maximum ponding depth. The flux at this time may be either negative (into the soil but at a lesser rate than the maximum allowed rate) or positive (seepage out of the soil system). If we further assume that the rainfall rate now declines until maximum ponding depth cannot be maintained, a Neumann flux condition must be reinstated. That is, whenever the flux calculated for the ponding condition becomes greater in magnitude (less in an absolute sense due to our sign convention) than that which can be maintained by the rainfall rate, the boundary condition must be changed to a flux condition.

The function of BCPREP is to prepare a rainfall flux vector FLX(NP) and two pointer arrays NPFLX(NPP) and NPCON(NPP). (The maximum ponding depth vector HCON(NP) is an input quantity.) Routine BC then uses these arrays to actually implement the boundary conditions. For example, if NP = NPFLX(NPP) $\neq$ 0, node NP is assigned the flux condition FLX(NP). If, on the other hand, NP = NPCON(NPP) $\neq$ 0, node NP is assigned the constant-pressure condition HCON(NP).

Supporting calculations are carried out in routines SURF, VELT, Q4D, Q4S, SFLOW, and Q4TH. Subroutine SURF identifies boundary sides. These sides are then specified in terms of the elements to which they belong and the nodes that subtend them. Side lengths and direction cosines of outwardly directed normal vectors are calculated. Routines VELT and Q4D are used to determine Darcy velocity vectors and total heads at all nodes from a predetermined pressure-head distribution (in a previous iteration). With SFLOW, Q4S, and Q4TH, flows are determined in two different ways. First, the surface integral of Eq. (41) is evaluated for each boundary element in routine Q4S using two-point Gauss quadrature. Resulting element flow rates are assembled into a boundary flow rate vector, and trapezoidal time integration is used in SFLOW to obtain the moisture passing through the boundary since the last time step. These flows are classified according to the boundary condition on the surface from which they originate. Second, a space integral over the water content is evaluated. Its rate of change from that of the last time step is determined as a check on the total flow through the boundary.

Finally input-output functions are performed almost exclusively in routines DATAIN, PRINTT, and STORE. Variables pertaining to discretization of the geometry of the system and the simulation time are read in DATAIN. Others relating to soil properties, boundary-initial conditions, and numerical convergence are also read. These input quantities are checked for consistency whenever possible and are printed out to give a complete record of the simulation. A thorough description of the input for DATAIN is given in Appendix E. Output of calculated variables occurs in PRINTT and STORE. Subroutine PRINTT prints flow information, pressure heads, total heads, water contents, and Darcy velocity distributions as specified by parameter KPR. Subroutine STORE writes the same information, in addition to nodal point and element descriptors, on an auxiliary storage device, a magnetic tape for example. Its operation is controlled by variables

KSTR and, to a limited extent, NSTRT. Auxiliary storage may be used either for plotting by another program or for restarting using a previously determined pressure distribution as the initial condition for continued calculation.

IV. RESULTS

In this section our computer code is checked in two different ways--comparison with experimental data and comparison with another computer program. Emphasis, however, is placed on problem definition and setup to illustrate the use of our program. Detailed card-by-card and line-by-line listings of input and output for two of the problems are given in Appendices A and B.

1. Coweeta Inclined Soil Column. Investigators of the Coweeta Hydrologic Laboratory in North Carolina have made extensive use of inclined physical soil models to study the interrelation among base flow, unsaturated soil moisture movement, and evapotranspiration. Results from their Models I and II are presented by Hewlett (1961). Data from Model IV has recently been shown and analyzed by Scholl and Hibbert (1973). Our mathematical analysis is concentrated on the results of Hewlett and Hibbert (1963) obtained from Model III. We further restrict our attention to the measured values of outflow vs. time, reserving their tension and moisture-content distributions for future study.

The physical system consists of an inclining concrete trough, the inner dimensions of which are given in Fig. 6b. It is filled for the most part with a Halewood sandy loam soil with a texture of 60 percent sand, 18 percent silt, and 22 percent clay (Hewlett and Hibbert, 1963). Soil under the outflow level, however, is graded to sand, gravel, and rock to simulate stream bank conditions and to allow free drainage.

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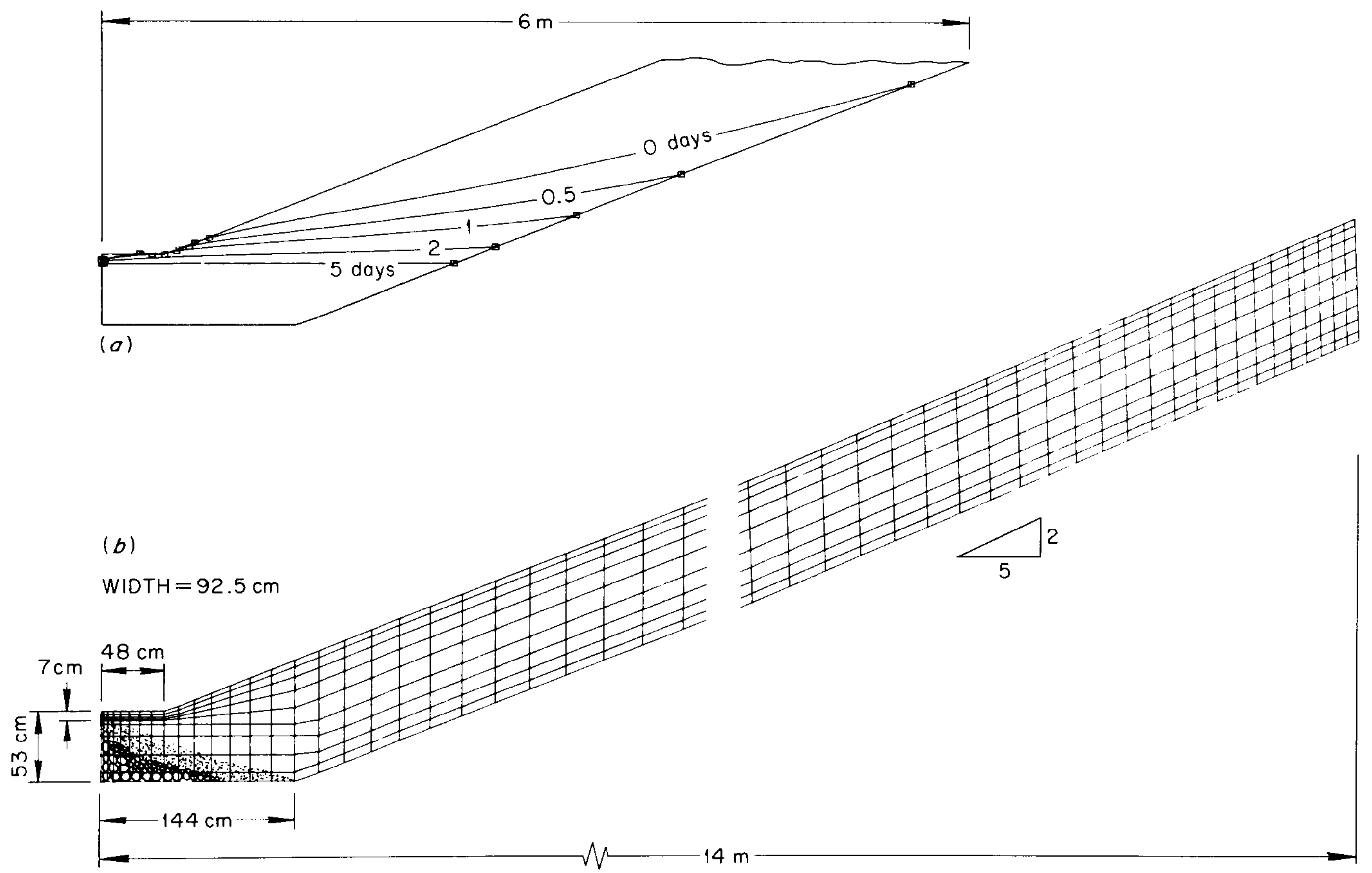

Figure 6. Coweeta Inclined Soil Model. (a) Simulated water-table decline for conductivity parameters K_s = 450 cm/day, h_c = -30 cm, and p = 5. (b) Physical characteristics and finite-element discretization.

After soaking the upper surface for several days, the structure was covered with a plastic film to prevent evaporation. The outflow rate coming from the drainage tube was then measured as a function of time (Fig. 7). A much more complete description of the physical model, its instrumentation, and results obtained therefrom may be found in Hewlett and Hibbert (1963).

Before this system was mathematically modeled, a number of simplifying assumptions were made. The influence of the sand, gravel, and rock (Fig. 6b) on outflow was assumed to be negligible since this material lies below the outflow level in a region where Darcy velocities would be expected to be minimal. Three-dimensional flow near the outflow tube was taken to be inconsequential, and seepage was allowed to occur from a height of 46 cm to a height of 53 cm across the entire width of the front face. All boundaries except for this portion of the front face were taken to be impervious for the transient calculation. Seepage was allowed to occur over the entire top surface whenever warranted. However, seepage water was assumed to pass instantaneously to the outflow without further infiltration into the soil.

Initial conditions and soil properties presented a problem. To our knowledge, none of these quantities was measured for Model III. Hewlett (1961) reported 41 percent as the initial volumetric water content for a similar experiment with an earlier model. For our simulation we assumed the initial moisture distribution to be that which would have been obtained if the entire slab had been wetted to saturation

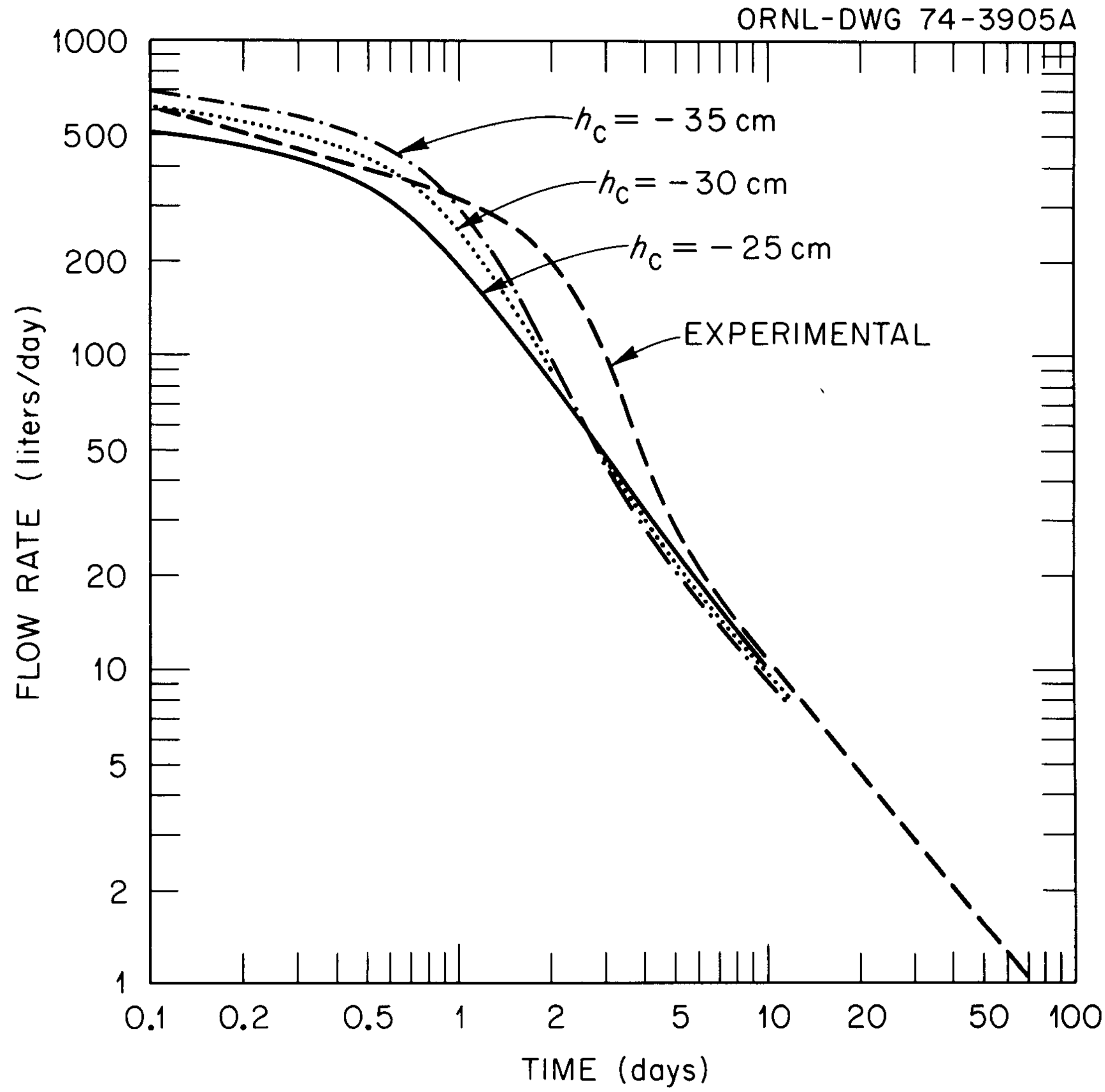

Figure 7. Outflows as Functions of Time. For the simulated curves saturated conductivity and pore-size distribution parameters were held constant at K_s = 450 cm/day and p = 5, respectively.

by a heavy rainfall on the top surface and then allowed to drain until the total volumetric water content was the same 41 percent. The moisture characteristic was taken from Scholl and Hibbert (1973) (Model IV) and fitted with a smooth curve (Fig. 8). Since there were no measurements of conductivity as a function of either pressure or water content, the Gardner (1958) form,

$$K = \frac{K_s}{\left(\frac{h}{h_c}\right)^d + 1} \tag{74}$$

was used.

Saturated conductivity K_s, critical pressure h_c, and pore-size distribution index d were then treated as adjustable parameters, and outflow profiles were generated. Three profiles for differing h_c values with K_s and d fixed may be compared among themselves and with the experimental curve in Fig. 7. Corresponding conductivity-pressure functions are shown in Fig. 8. The soil-parameter values for K_s, h_c, and d are all quite reasonable when compared to those of Bouwer (1964) for a sandy soil. Making the unsaturated soil less conducting by increasing h_c tends to decrease short-term subsurface flow ($t \lesssim 1$ day) and increase long-term subsurface flow ($t \gtrsim 10$ days). Water table ($h = 0$) contours corresponding to our best simulation are shown in Fig. 6a. The water-table position remained essentially unchanged for times greater than five days. Hewlett and Hibbert (1963) observed a power-law decay in their outflow rate for the first 36 hours and after a five-day

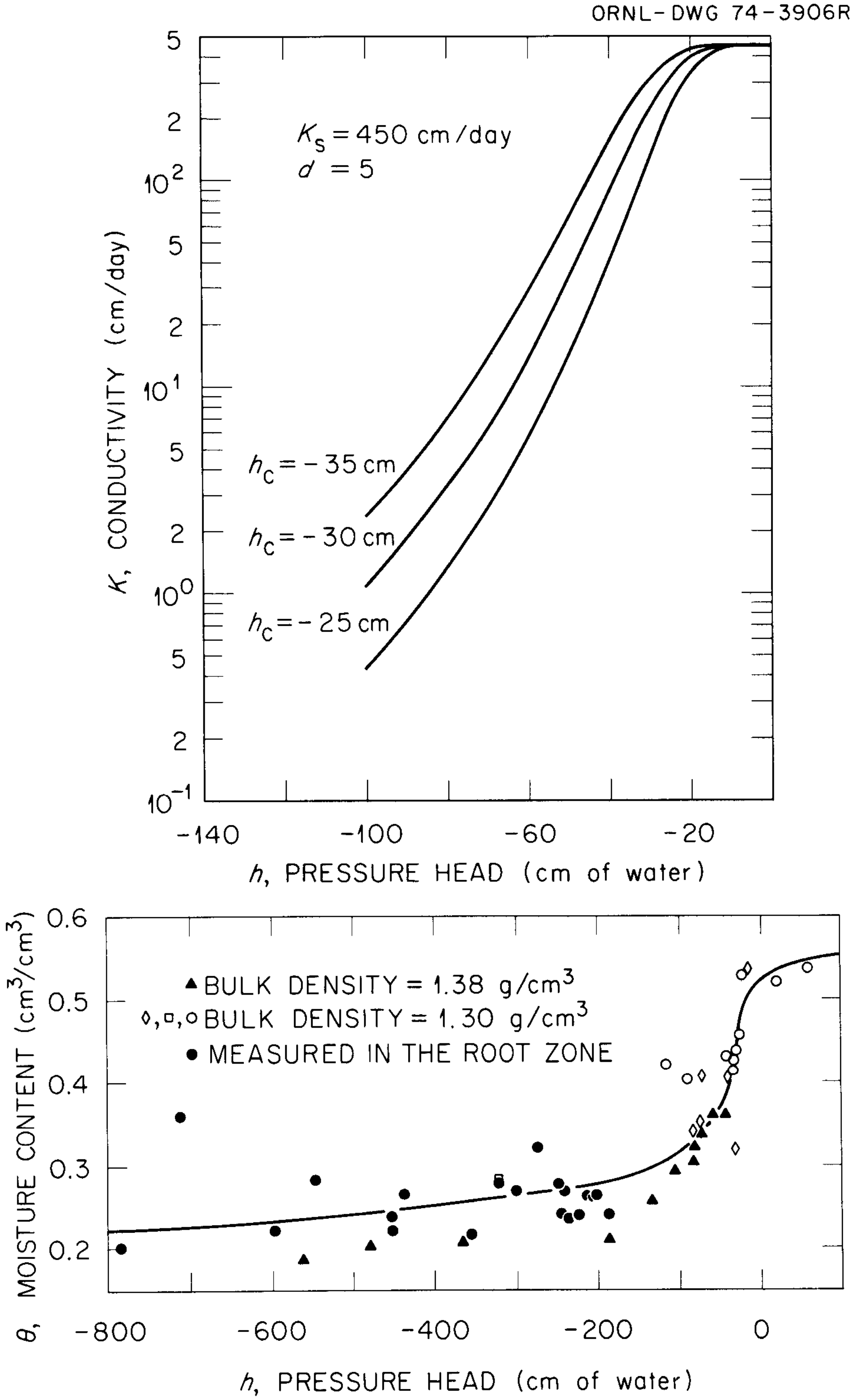

Figure 8. Soil Properties of Halewood Sandy Loam. (a) Hydraulic conductivities obtained from a Gardner form factor. (b) Moisture characteristic. Experimental data of Scholl and Hibbert [1973] as fitted by a smooth curve.

transition period a second, but different, power-law decay (see Fig. 7). The first period, according to Fig. 6a, is characterized by a rapidly dropping free-water surface. In the second period there is little or no movement of this surface since it has essentially reached its final equilibrium position, and the outflow is controlled entirely by flow through the large mass of unsaturated soil lying above the water table. Agreement between simulated and measured outflow rates is worst during the transition period. The simulated rate and also the water table fall too rapidly. Perhaps a further adjustment of the conductivity parameters would alleviate this problem. Water table contours in Fig. 6a for times $t \leq 2$ days imply seepage through the top surface of the slab. Such flows contributed 76 percent of the total simulated flow rate at $t = 0$ and 8 percent at $t = 2$ days. However, no seepage was observed experimentally.[1] This discrepancy could be due either to the assumed initial conditions or to the presence of the highly conductive gravel and rock, which was not accounted for in the simulation. It is sufficient here, however, to exhibit the generally encouraging comparison of our simulation to experimental data and the physically reasonable way in which the water table behaves.

The spatial mesh consists of 612 elements and 690 nodes as shown in Fig. 6. The width of the stored operator matrix [C] was IHBP = 12. The latter quantity is important for two reasons. Computing time varies as its square, and for large problems (core storage $\gtrsim$ 1000K bytes) the

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[1]Private communication from Lloyd W. Swift, Jr., Coweeta Hydrologic Laboratory.

core requirement varies directly as IBHP. For this particular problem storage and time requirements on an IBM 360/91 computer were 500K bytes and 16.5 minutes for 13.5 days of simulation. Appendix A presents operational details appropriate for a test-case computer run on the above problem. Input and output are given. Listings of subroutine SPROP, COMMON statements, and DATA statements are not included, however, since they appear in the program listing in Appendix C. Ordinarily, one must change SPROP to conform with the form of the soils data and should change the COMMON and DATA statements to minimize core storage requirements.

2. Freeze's Idealized Flow System. R. A. Freeze (1971a) has developed a computer program (Freeze, 1972c) which is comparable to ours. His model, like ours, is based on Eq. (28) and therefore treats saturated and unsaturated zones in a unified manner. In addition, the Freeze model allows transient analysis, nonhomogeneous and anisotropic geological formations, and any generalized configuration of all pertinent boundary conditions. In addition to a two-dimensional capability, which we also have, Freeze's model has a three-dimensional capability. The biggest differences, however, are in the numerical implementation. Freeze uses a block-centered rectangular grid, finite-difference spatial discretization, and line successive overrelaxation for solution of the matrix equations which arise. We, on the other hand, use a quadrilateral finite-element grid, Galerkin spatial discretization, and Gaussian elimination.

As Freeze so clearly points out in his closing comments in the (1971b) article, there are very real limitations in the physics-based approach. These limitations are computer performance (both core size and computing time), numerical convergence, and data availability. We have introduced the different numerical techniques in an effort to alleviate the first two of these limitations. We have been partially successful, but much work remains, principally in handling the non-linearities arising from the unsaturated soil properties. Basically, it is our feeling that finite elements provide a more flexible way of characterizing the physical geometry than does a rectangular grid. By exploiting this flexibility one can reduce the number of nodes and, hence, the computing times with very little loss in overall accuracy. In addition, unpublished work performed in conjunction with the Reeves and Miller (1974) paper showed that, at least in a one-dimensional application for the soils and boundary conditions considered therein, linear Galerkin had convergence superior to that of a comparable finite-difference algorithm. Practically speaking, better convergence means that comparable accuracy can be achieved with fewer nodes. Finally, it was felt that exact solution of the linearized equations by Gaussian elimination would enhance both stability and convergence when compared to the approximate line-successive-overrelaxation method.

A number of analyses of idealized systems have been presented by Freeze (1971a, 1971b, 1972a, 1972b). There have been watersheds, groundwater basins, and earth dams. All have been used to explore effects of the unsaturated zone upon the total subsurface flow regime. A very small laboratory-sized watershed measuring 6m by 3m, presented in Freeze (1972a), served as a test case for his computer program in the (1972c) document. We have used this same system both as a debugging aid and as a vehicle whereby the efficiency of the different numerical methods could be compared.

The flow system is shown in Fig. 9. It is composed of a highly permeable sand, the unsaturated properties of which are shown in Fig. 10. To obtain initial conditions, pressure-head values were prescribed along the stream channel, part of the slope, and the upper plateau. Taking all other boundaries to be impermeable, a steady state was determined, pressure heads of which were the initial conditions for the transient calculation. (The careful reader should be alerted here to the fact that initial conditions described above are used in Freeze (1972c) but not in the corresponding calculation of Freeze (1972a).)

Using Freeze's transient boundary conditions (Fig. 9a), and Freeze's rectangular grid (Fig. 9b), the water table rise of Fig. 11a was generated with the Reeves-Duguid code. Selected results obtained from our program may be compared with their counterparts obtained from the Freeze routine in Figs. 11b and 11c. Comparative computing times are presented in Table 1 (Columns "Freeze" and "Reeves-Duguid #1" are appropriate here). For the steady-state calculation, where the initial guess at the solution is poor, the finite-element-Galerkin algorithm is obviously superior. There is a factor-of-five reduction in computing

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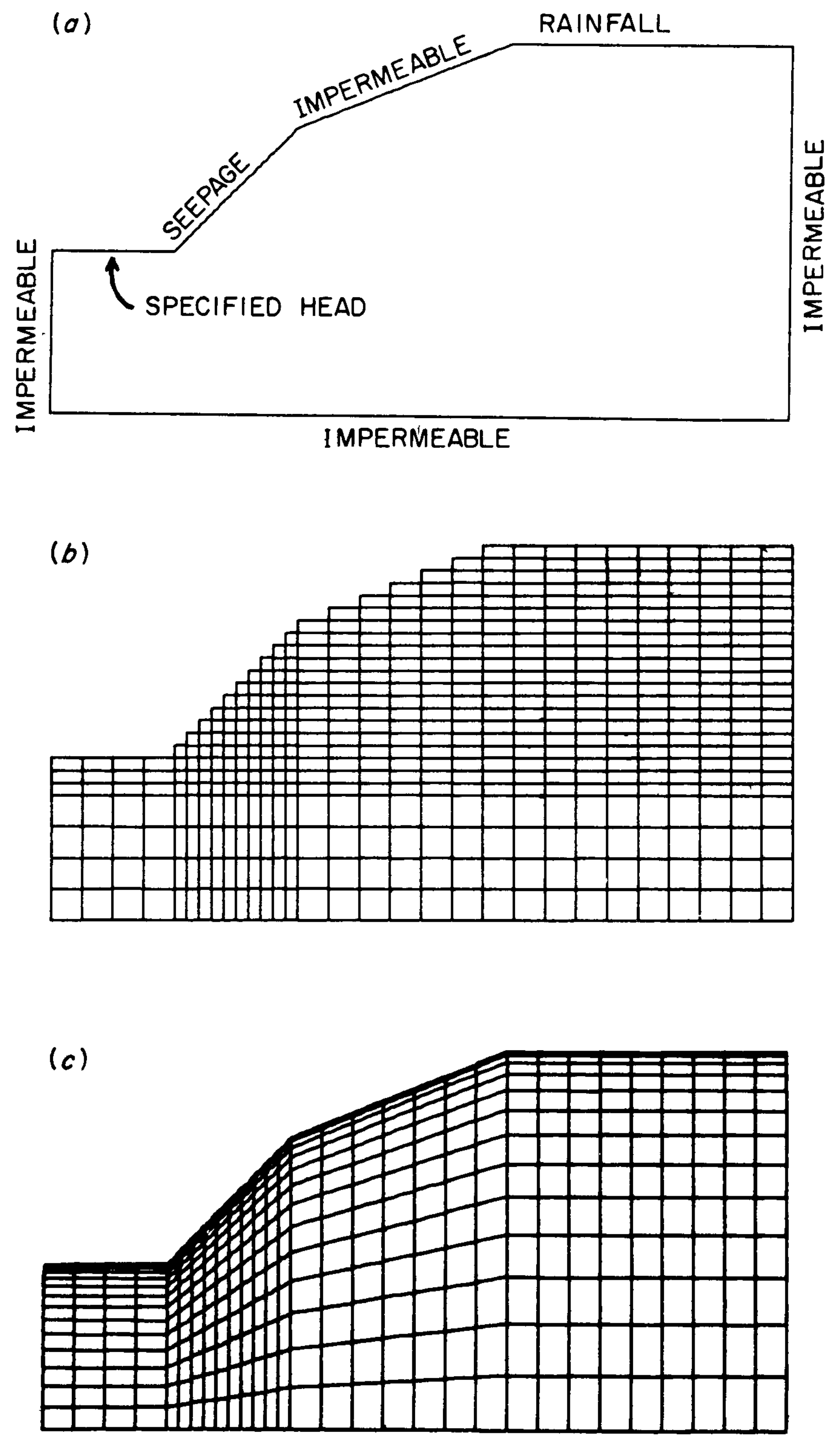

Figure 9. Freeze's Idealized Watershed. (a) Transient boundary conditions. (b) Freeze's rectangular grid. (c) Spatial mesh for the Reeves-Duguid calculation, Case 2.

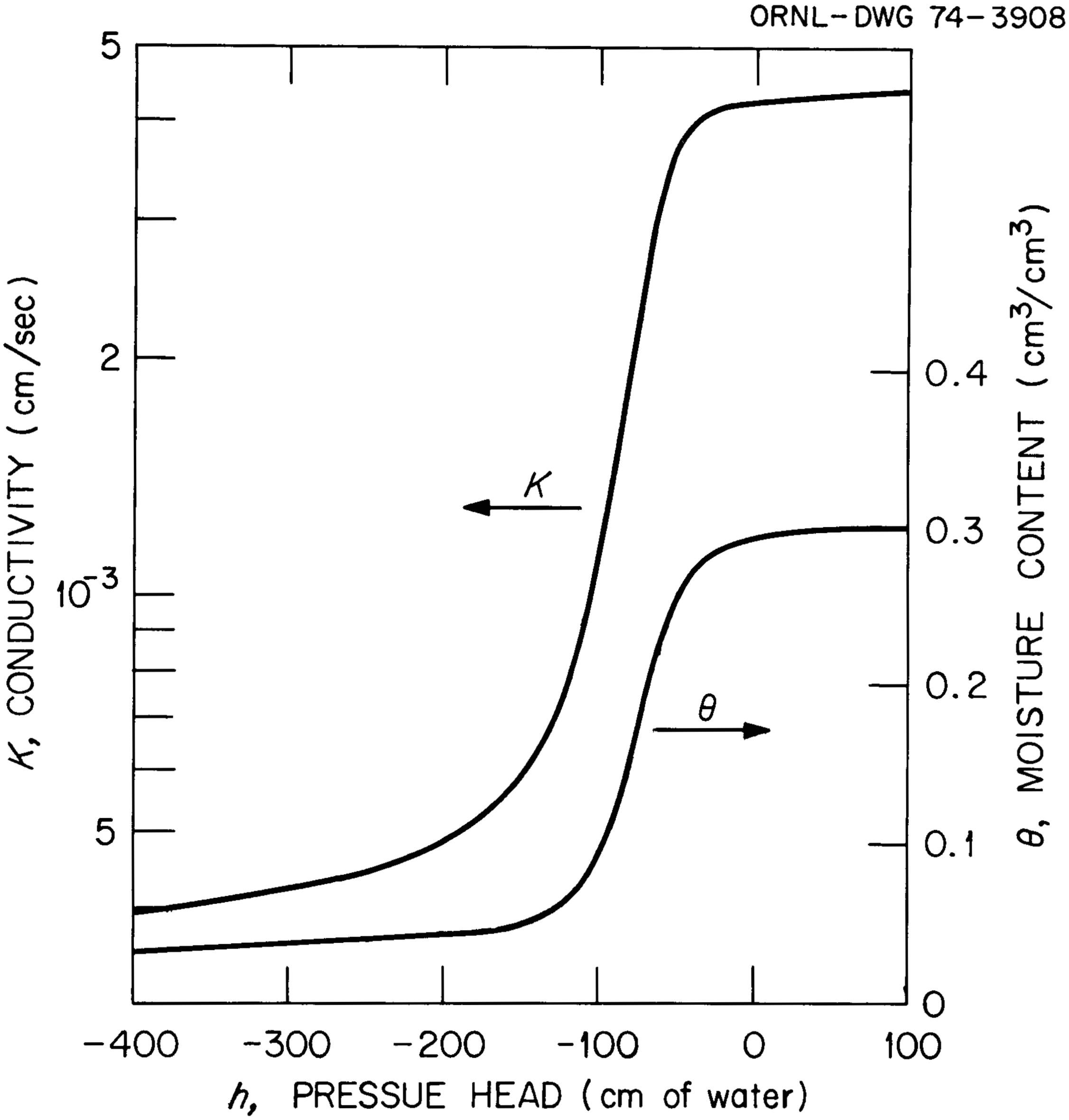

Figure 10. Hydraulic Conductivity and Soil-Moisture Characteristics of a Hypothetical Sandy Soil.

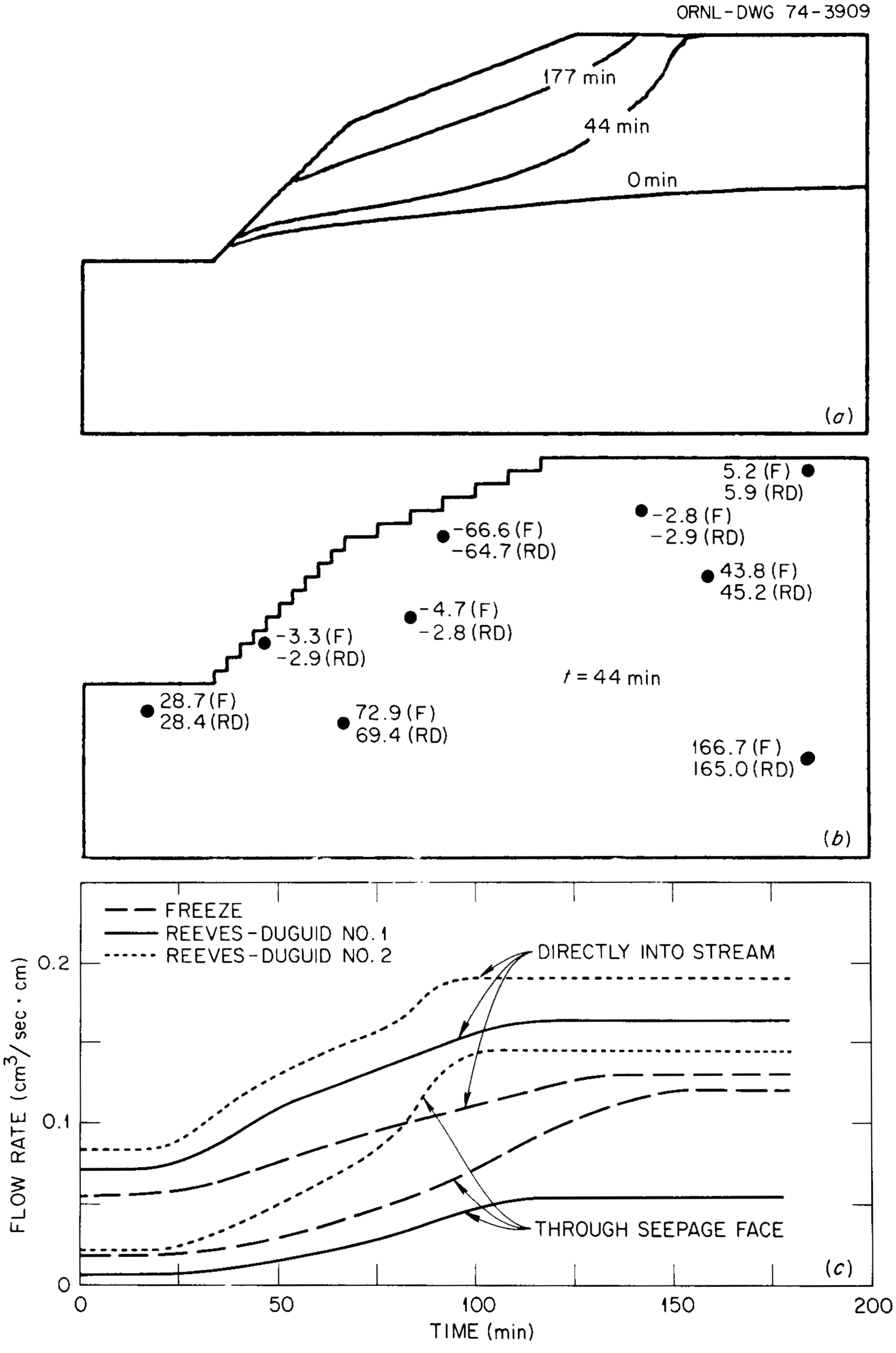

Figure 11. (a) Water-Table Rise as Determined by Both Reeves-Duguid Calculations. (b) Selected pressure heads obtained by the Freeze (F) program and by the Reeves-Duguid (RD), Case 1, analysis. (c) Subsurface flow hydrograph obtained by the Freeze and Reeves-Duguid calculations.

TABLE 1

Time and Storage Parameters

	Freeze	Reeves-Duguid #1	Reeves-Duguid #2
Total computing time (min)	4.88	4.64	2.42
Steady-state time (sec)	29.8	5.7	3.0
Transient-state time (min)	4.38	4.61	2.37
Total core storage (bytes)	-	500K	380K

time. There is no improvement for the transient-state calculation, however, and the finite-element technique actually takes 5 percent longer. We did not determine the minimum core storage requirement of the Freeze code because of our unfamiliarity with his dimensioning. However, we expect his code to be superior in this category since the line-successive-overrelaxation method requires storage of a tridiagonal matrix having the same order as the maximum number of vertical nodes, a 24 X 3 matrix (.58K bytes in double precision), for the grid shown in Fig. 10b. The finite-element Galerkin algorithm, on the other hand, requires a handed matrix of an order equal to the number of nodes, a 571 X 27 matrix (120K bytes in double precision) for the grid of Fig. 9b.

One must trade off the core storage advantage of the line-successive-overrelaxation method to obtain the computer-time advantage of the finite-element Galerkin algorithm. Gains can be maximized and losses minimized, however, by exploiting the finite-element spatial discretization. Although we have not explored this possibility exhaustively, we do present an example, labeled "Reeves-Duguid #2," in Table 1. Spatial mesh is presented in Fig. 9c which reduces the number of nodes from 571 to 434 and the band width from IHBP=27 to IHBP=16. The latter quantity has a special significance since computing times vary quadratically with changing band width, the variation being linear with respect to the number of nodes. Relative to Case 1 (see Table 1) the overall computing time is reduced by about 50 percent and the core-storage requirement by approximately 25 percent. Water table rises (Fig. 11a) were identical for the two Reeves-Duguid cases.

Calculation of subsurface flows proved to be a problem, as illustrated in Fig. 11c. Each flow rate shown is obtained by integrating moisture fluxes over appropriate regions of the surface. Since these fluxes depend on the gradient of the pressure head, which is itself accurate only to the second order in the spatial increments, the fluxes are accurate only to the first order in the spatial increments. It is therefore not surprising that the flow rates do not agree in spite of the generally good agreement among pressure heads for the three calculations (see Figs. 11a and 11b). Despite substantial differences between the "Freeze" and "Reeves-Duguid #1" curves, mass is conserved[2] in each to less than 8 percent; there appears to be no compelling reason for choosing one over the other. For the calculation labeled "Reeves-Duguid #2," there was a 25 percent loss of mass.[3] However, based on numerous hand calculations and numerical experiments, we conclude that there are no bugs in the outflow coding, the discrepancy is not a time-step truncation error, it is not a result of the tolerance allowed for convergence, and reduction of the spatial increment sizes does not alleviate the problem. It appears possible that the bilinear

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[2]The change in the internal mass of water is determined both by a time integral over all surface flow rates and a volume integral over the moisture content.

[3]Outflow rates for the Coweeta sloping slab (Fig. 7) were obtained directly from volume integrals over moisture content at each time step. They therefore have a higher order of accuracy than the outflow rates of Fig. 11c. The Coweeta problem had no infiltration from rainfall and no division of subsurface flow into seepage and direct flow into a stream, both of which made the volume-integral calculation possible.

interpolation surfaces across the elements of the seepage surface are incapable of bending so as to accommodate seepage through a sloping boundary and internal continuity requirements. Perhaps the addition of triangular elements will correct this difficulty. We will, however, reserve this matter for future study.

Appendix B presents operational details appropriate for a test-case computer run of our Case 2 calculation. Input, output, subroutine SPROP, COMMON blocks, and DATA statements are listed. Moisture content, water capacity, and conductivity are obtained by interpolation. SPROP is written accordingly, and, of course, must replace the version of SPROP listed in Appendix C, which is appropriate for the Coweeta problem. By also inserting the COMMON, DIMENSION, and DATA statements shown in Appendix A into the program, the core storage requirement can be minimized to the 340K bytes shown in Table 1.

V. NOTATION

$[{}_rA]$	Coefficients of the transient terms for the r-th element.
b_i	Dirichlet boundary condition at node i.
$[{}_rB]$	Operator matrix for the r-th element.
$[C]$	Assembled operator matrix for all elements.
$[{}_rC]$	Combination of $[{}_rA]$ and $[{}_rB]$ including the time-integration algorithm.
d	Pore-size distribution index of the Gardner conductivity relation.
$\{{}_rD\}$	Gravitational-flux vector for the r-th element.
e	Dilatation of the medium.
f	Function of integration.
F	Generalized storage constant.
g	Acceleration of gravity.
h	Pressure head.
$\dot{h}$	Time derivative of pressure head.
h_c	Critical pressure of the Gardner conductivity relation.
${}_rh$	Pressure head for the r-th element.
${}_r\dot{h}$	Time derivative of ${}_rh$.
$\{h\}$	Assembled values of the unknown coefficients.
$\{{}_rh\}$	Unknown coefficients for the r-th element.
$\{{}_r\dot{h}\}$	Time derivative of $\{{}_rh\}$.
H	Hydraulic head.
i	As a superscript it denotes an iteration parameter.

$[{}_rJ]$	Jacobian matrix for the r-th element.
${}_rJ$	Determinant of $[{}_rJ]$.
$\bar{\bar{k}}$	Intrinsic permeability tensor.
$\bar{\bar{K}}$	Conductivity tensor.
K_s	Saturated conductivity of the Gardner conductivity relation.
L	Differential operator.
m	Limit of summation.
n	Porosity.
$\bar{n}$	Unit normal vector.
$\{N\}, N_i$	Basis function.
p	Pressure.
p_o	Atmospheric pressure.
[P]	Matrix used in the numerical evaluation of the Jacobian.
r	Refers to the r-th finite element.
$\{{}_rR\}$	Vector for element r containing both gravitational-flux and time-integration components.
$\{R\}$	Vector $\{{}_rR\}$ assembled over all elements.
$\{{}_rR'\}$	Boundary flux for the r-th element.
$\{R'\}$	Vector $\{{}_rR'\}$ assembled over all elements.
s_j, τ_j	Local coordinates of the nodes j = 1,2,3, and 4.
S	Degree of saturation.
${}_rS$	Surface area of the r-th element.
t	Time.
$\bar{u}$	Displacement of the medium.

V	Volume.
${}_rV$	Volume of the r-th element.
$\bar{V}_{fs}$	Flux of fluid relative to solid.
$\bar{V}_s$	Velocity of the solids.
W_j	Weighting function.
$\bar{x}$	Position vector.
x_{ij}	Coordinate difference ${}_rx_i - {}_rx_j$ for nodes i and j of element r.
${}_rx$	Global coordinate of a point within the r-th element.
$\{{}_rx\}$	Global coordinate of the nodes of the r-th element.
$\{Y\}$	Assembled load vector containing boundary and gravitational fluxes and time-integration components.
z	Elevation head.
z_{ij}	Coordinate difference ${}_rz_i - {}_rz_j$ for nodes i and j of element r.
${}_rz$	Global coordinate of a point within the r-th element.
$\{{}_rz\}$	Global coordinate of the nodes of the r-th element.
α	Coefficient of compressibility of the medium.
α'	Modified coefficient of compressibility of the medium.
β	Coefficient of compressibility of water.
β'	Modified coefficient of compressibility of water.
Γ	Hubbert's force potential.
ε_{ij}	Strain tensor for the medium.
θ	Moisture content.

λ_s	Lamé's elastic constant.
μ_f	Viscosity of water.
μ_s	Lamé's shear modulus.
ρ_f^o	Initial density.
ρ_f	Density of water.
σ	Incremental pressure.
ϕ_i	Expansion coefficients relative to the basis functions N_i.
Φ	Unknown solution to the equation $L(\Phi) = 0$.
Φ'	Trial solution.
$_r\phi'$	Trial solution for the r-th element.
ψ_1, ψ_2	General functions used in Green's theorem.
ω	Time integration parameter.

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APPENDIX A

INPUT AND OUTPUT FOR COWEETA PROBLEM

INPUT

```
CF.        ...  1.  TITLE.  FORMAT (I5,9A8)*  ...

 1273 COWEETA PROBLEM


CF.        ...  2.  BASIC INTEGER PARAMETERS.  FORMAT (16I5)  ...

  690  612    1    0   50    0    1   43    0    0    0    0   25    3


CF.        ...  3.  BASIC REAL PARAMETERS.  FORMAT (8F10.0)  ...

.0033     .05       .25       0.        0.        .01       .01       1.
980.      .013      1.


CF.        ...  4.  PRINTER OUTPUT CONTROL.  FORMAT (80I1)  ...

                                                      1


CF.        ...  5.  MATERIAL PROPERTIES.  FORMAT (8F10.0)  ...

0.        0.        .5        0.        0.


CF.        ...  7.  SOIL PROPERTIES IN TABULAR FORM.  FORMAT (8F10.0)  ...

-11294.5  -9381.8   -7736.2   -6408.9   -5292.2   -4381.0   -3626.9   -2983.3
-2475.9   -2053.3   -1694.9   -1403.1   -1156.4   -958.5    -794.6    -654.2
-542.6    -449.2    -371.2    -307.0    -252.6    -209.6    -174.0    -150.
-125.     -100.     -85.      -70.      -60.      -50.      -40.      -35.
-30.      -25.      -20.      -10.      0.        10.       20.       30.
40.       50.       60.
0.118     0.125     0.133     0.140     0.148     0.156     0.163     0.171
0.178     0.186     0.194     0.201     0.209     0.216     0.224     0.232
0.239     0.247     0.254     0.262     0.270     0.277     0.285     0.291
.3003     .3151     .3273     .3425     .3547     .3691     .3863     .4087
.4373     .4668     .4910     .5110     .5201     .5263     .5308     .5353
.5392     .5425     .5452
```

* COMMENT CARDS ARE TO BE DELETED FROM DATA SET. THEY ARE INCLUDED HERE AS A CROSS REFERENCE TO APPENDIX E.

```
450.     -30.     5.


 3.54D-06  4.27D-06  5.17D-06  6.25D-06  7.56D-06  9.14D-06  1.10D-05  1.34D-05
 1.62D-05  1.95D-05  2.36D-05  2.85D-05  3.46D-05  4.18D-05  5.04D-05  6.12D-05
 7.38D-05  8.91D-05  1.08D-04  1.30D-04  1.58D-04  1.91D-04  2.30D-04  2.70D-04
   4.75E-4   7.23E-4   9.05E-4   1.13E-3   1.31E-3   1.70E-3   3.74E-3   5.44E-3
   6.16E-3   5.44E-3   3.74E-3   1.30E-3   7.00E-4   5.40E-4   4.80E-4   4.20E-4
   3.60E-4   3.00E-4   2.40E-4


CF.      ...  8.  NODAL-POINT POSITIONS.  FORMAT (I5,2F10.3)  ...

    1       0.0       0.0
    2       0.0       6.730
    3       0.0      20.000
    4       0.0      34.333
    5       0.0      43.000
    6       0.0      46.000
    7       0.0      47.000
    8       0.0      48.500
    9       0.0      50.500
   10       0.0      53.000
   11     2.000       0.0
   12     2.000       6.730
   13     2.000      20.000
   14     2.000      34.333
   15     2.000      43.000
   16     2.000      46.000
   17     2.000      47.000
   18     2.000      48.500
   19     2.000      50.500
   20     2.000      53.000
   21     5.071       0.0
   22     5.071       6.730
   23     5.071      20.000
   24     5.071      34.333
   25     5.071      43.000
   26     5.071      46.000
   27     5.071      47.000
   28     5.071      48.500
   29     5.071      50.500
   30     5.071      53.000
   31     9.213       0.0
   32     9.213       6.730
   33     9.213      20.000
   34     9.213      34.333
   35     9.213      43.000
   36     9.213      46.000
   37     9.213      47.000
   38     9.213      48.500
   39     9.213      50.500
   40     9.213      53.000
   41    14.430       0.0
   42    14.430       6.730
   43    14.430      20.000
   44    14.430      34.333
   45    14.430      43.000
   46    14.430      46.000
   47    14.430      47.000
   48    14.430      48.500
   49    14.430      50.500
   50    14.430      53.000
   51    20.710       0.0
   52    20.710       6.730
   53    20.710      20.000
   54    20.710      34.333
   55    20.710      43.000
   56    20.710      46.000
   57    20.710      47.000
   58    20.710      48.500
   59    20.710      50.500
   60    20.710      53.000
   61    28.060       0.0
   62    28.060       6.730
   63    28.060      20.000
```

64	28.060	34.333
65	28.060	43.000
66	28.060	46.000
67	28.060	47.000
68	28.060	48.500
69	28.060	50.500
70	28.060	53.000
71	36.490	0.0
72	36.490	6.730
73	36.490	20.000
74	36.490	34.333
75	36.490	43.000
76	36.490	46.000
77	36.490	47.000
78	36.490	48.500
79	36.490	50.500
80	36.490	53.000
81	45.950	0.0
82	45.950	6.730
83	45.950	20.000
84	45.950	34.333
85	45.950	43.000
86	45.950	46.000
87	45.950	47.000
88	45.950	48.500
89	45.950	50.500
90	45.950	53.000
91	56.560	0.0
92	56.560	6.730
93	56.560	20.000
94	56.560	34.333
95	56.560	43.000
96	56.560	46.830
97	56.560	48.910
98	56.560	50.740
99	56.560	53.700
100	56.560	56.420
101	68.190	0.0
102	68.190	6.730
103	68.190	20.000
104	68.190	34.333
105	68.190	43.000
106	68.190	47.960
107	68.190	51.500
108	68.190	54.460
109	68.190	58.050
110	68.190	61.080
111	80.900	0.0
112	80.900	6.730
113	80.900	20.000
114	80.900	34.333
115	80.900	43.000
116	80.900	49.200
117	80.900	54.330
118	80.900	58.530
119	80.900	62.800
120	80.900	66.160
121	94.680	0.0
122	94.680	6.730
123	94.680	20.000
124	94.680	34.333
125	94.680	43.000
126	94.680	50.550
127	94.680	57.400
128	94.680	62.940
129	94.680	67.960
130	94.680	71.670
131	109.500	0.0
132	109.500	6.730
133	109.500	20.000
134	109.500	34.333
135	109.500	43.000
136	109.500	51.990
137	109.500	60.710
138	109.500	67.680
139	109.500	73.500
140	109.500	77.600
141	125.500	0.0
142	125.500	6.730
143	125.500	20.000

144	125.500	34.333
145	125.500	43.000
146	125.500	53.550
147	125.500	64.270
148	125.500	72.810
149	125.500	79.490
150	125.500	84.000
151	142.500	0.0
152	142.500	6.730
153	142.500	20.000
154	142.500	34.333
155	142.500	43.000
156	142.500	55.200
157	142.500	68.060
158	142.500	78.250
159	142.500	85.850
160	142.500	90.800
161	160.516	6.459
162	160.516	13.190
163	160.516	22.037
164	160.516	34.333
165	160.516	46.079
166	160.516	61.850
167	160.516	74.928
168	160.516	85.314
169	160.516	93.006
170	160.516	98.006
171	179.651	14.113
172	179.651	20.844
173	179.651	29.691
174	179.651	40.654
175	179.651	53.733
176	179.651	69.504
177	179.651	82.582
178	179.651	92.968
179	179.651	100.660
180	179.651	105.660
181	199.858	22.195
182	199.858	28.927
183	199.858	37.774
184	199.858	48.736
185	199.858	61.815
186	199.858	77.586
187	199.858	90.665
188	199.858	101.050
189	199.858	108.743
190	199.858	113.743
191	221.135	30.706
192	221.135	37.438
193	221.135	46.285
194	221.135	57.247
195	221.135	70.326
196	221.135	86.097
197	221.135	99.176
198	221.135	109.561
199	221.135	117.254
200	221.135	122.254
201	243.483	39.646
202	243.483	46.377
203	243.483	55.224
204	243.483	66.187
205	243.483	79.266
206	243.483	95.037
207	243.483	108.115
208	243.483	118.501
209	243.483	126.193
210	243.483	131.193
211	266.903	49.013
212	266.903	55.745
213	266.903	64.592
214	266.903	75.554
215	266.903	88.633
216	266.903	104.404
217	266.903	117.483
218	266.903	127.868
219	266.903	135.561

220	266.903	140.561
221	291.393	58.809
222	291.393	65.541
223	291.393	74.388
224	291.393	85.350
225	291.393	98.430
226	291.393	114.201
227	291.393	127.279
228	291.393	137.664
229	291.393	145.357
230	291.393	150.357
231	316.954	69.034
232	316.954	75.765
233	316.954	84.612
234	316.954	95.575
235	316.954	108.654
236	316.954	124.425
237	316.954	137.503
238	316.954	147.889
239	316.954	155.582
240	316.954	160.582
241	343.586	79.687
242	343.586	86.418
243	343.586	95.265
244	343.586	106.228
245	343.586	119.307
246	343.586	135.078
247	343.586	148.156
248	343.586	158.542
249	343.586	166.234
250	343.586	171.234
251	371.289	90.768
252	371.289	97.499
253	371.289	106.346
254	371.289	117.309
255	371.289	130.388
256	371.289	146.159
257	371.289	159.237
258	371.289	169.623
259	371.289	177.316
260	371.289	182.316
261	400.063	102.278
262	400.063	109.009
263	400.063	117.856
264	400.063	128.819
265	400.063	141.898
266	400.063	157.669
267	400.063	170.747
268	400.063	181.133
269	400.063	188.825
270	400.063	193.825
271	429.908	114.216
272	429.908	120.947
273	429.908	129.794
274	429.908	140.757
275	429.908	153.836
276	429.908	169.607
277	429.908	182.685
278	429.908	193.071
279	429.908	200.763
280	429.908	205.763
281	460.824	126.582
282	460.824	133.313
283	460.824	142.160
284	460.824	153.123
285	460.824	166.202
286	460.824	181.973
287	460.824	195.051
288	460.824	205.437
289	460.824	213.130
290	460.824	218.130
291	492.812	139.377
292	492.812	146.108
293	492.812	154.955
294	492.812	165.918
295	492.812	178.997
296	492.812	194.768
297	492.812	207.846
298	492.812	218.232
299	492.812	225.925

300	492.812	230.925
301	525.870	152.600
302	525.870	159.331
303	525.870	168.178
304	525.870	179.141
305	525.870	192.220
306	525.870	207.991
307	525.870	221.069
308	525.870	231.455
309	525.870	239.148
310	525.870	244.148
311	559.999	166.252
312	559.999	172.983
313	559.999	181.830
314	559.999	192.793
315	559.999	205.872
316	559.999	221.643
317	559.999	234.721
318	559.999	245.107
319	559.999	252.799
320	559.999	257.799
321	598.601	181.692
322	598.601	188.424
323	598.601	197.271
324	598.601	208.233
325	598.601	221.312
326	598.601	237.083
327	598.601	250.162
328	598.601	260.547
329	598.601	268.240
330	598.601	273.240
331	635.308	196.375
332	635.308	203.107
333	635.308	211.954
334	635.308	222.916
335	635.308	235.996
336	635.308	251.767
337	635.308	264.845
338	635.308	275.230
339	635.308	282.923
340	635.308	287.923
341	671.209	210.736
342	671.209	217.467
343	671.209	226.314
344	671.209	237.277
345	671.209	250.356
346	671.209	266.127
347	671.209	279.205
348	671.209	289.591
349	671.209	297.283
350	671.209	302.284
351	706.304	224.774
352	706.304	231.505
353	706.304	240.352
354	706.304	251.315
355	706.304	264.394
356	706.304	280.165
357	706.304	293.243
358	706.304	303.629
359	706.304	311.321
360	706.304	316.322
361	740.592	238.489
362	740.592	245.220
363	740.592	254.067
364	740.592	265.030
365	740.592	278.109
366	740.592	293.880
367	740.592	306.958
368	740.592	317.344
369	740.592	325.036
370	740.592	330.037
371	774.074	251.881
372	774.074	258.613
373	774.074	267.460
374	774.074	278.422
375	774.074	291.501
376	774.074	307.272
377	774.074	320.351
378	774.074	330.736

379	774.074	338.429
380	774.074	343.429
381	806.749	264.951
382	806.749	271.682
383	806.749	280.530
384	806.749	291.492
385	806.749	304.571
386	806.749	320.342
387	806.749	333.421
388	806.749	343.806
389	806.749	351.499
390	806.749	356.499
391	838.617	277.698
392	838.617	284.430
393	838.617	293.277
394	838.617	304.240
395	838.617	317.319
396	838.617	333.090
397	838.617	346.168
398	838.617	356.553
399	838.617	364.246
400	838.617	369.246
401	869.678	290.123
402	869.678	296.854
403	869.678	305.701
404	869.678	316.664
405	869.678	329.743
406	869.678	345.514
407	869.678	358.593
408	869.678	368.978
409	869.678	376.671
410	869.678	381.671
411	899.934	302.225
412	899.934	308.956
413	899.934	317.803
414	899.934	328.766
415	899.934	341.845
416	899.934	357.616
417	899.934	370.695
418	899.934	381.080
419	899.934	388.773
420	899.934	393.773
421	929.382	314.005
422	929.382	320.736
423	929.382	329.583
424	929.382	340.546
425	929.382	353.625
426	929.382	369.396
427	929.382	382.474
428	929.382	392.860
429	929.382	400.552
430	929.382	405.552
431	958.024	325.461
432	958.024	332.193
433	958.024	341.040
434	958.024	352.002
435	958.024	365.082
436	958.024	380.853
437	958.024	393.931
438	958.024	404.316
439	958.024	412.009
440	958.024	417.009
441	985.859	336.595
442	985.859	343.327
443	985.859	352.174
444	985.859	363.136
445	985.859	376.216
446	985.859	391.987
447	985.859	405.065
448	985.859	415.450
449	985.859	423.143
450	985.859	428.143
451	1012.888	347.407
452	1012.888	354.138
453	1012.888	362.985
454	1012.888	373.948
455	1012.888	387.027
456	1012.888	402.798
457	1012.888	415.876
458	1012.888	426.262
459	1012.888	433.955

460	1012.888	438.955
461	1039.110	357.896
462	1039.110	364.627
463	1039.110	373.474
464	1039.110	384.437
465	1039.110	397.516
466	1039.110	413.287
467	1039.110	426.365
468	1039.110	436.751
469	1039.110	444.444
470	1039.110	449.444
471	1064.526	368.062
472	1064.526	374.793
473	1064.526	383.640
474	1064.526	394.603
475	1064.526	407.682
476	1064.526	423.453
477	1064.526	436.531
478	1064.526	446.917
479	1064.526	454.610
480	1064.526	459.610
481	1089.135	377.906
482	1089.135	384.637
483	1089.135	393.484
484	1089.135	404.447
485	1089.135	417.526
486	1089.135	433.297
487	1089.135	446.375
488	1089.135	456.761
489	1089.135	464.453
490	1089.135	469.453
491	1112.938	387.427
492	1112.938	394.158
493	1112.938	403.005
494	1112.938	413.968
495	1112.938	427.047
496	1112.938	442.818
497	1112.938	455.896
498	1112.938	466.282
499	1112.938	473.974
500	1112.938	478.974
501	1135.933	396.625
502	1135.933	403.356
503	1135.933	412.203
504	1135.933	423.166
505	1135.933	436.245
506	1135.933	452.016
507	1135.933	465.094
508	1135.933	475.480
509	1135.933	483.173
510	1135.933	488.173
511	1158.123	405.501
512	1158.123	412.232
513	1158.123	421.079
514	1158.123	432.042
515	1158.123	445.121
516	1158.123	460.892
517	1158.123	473.970
518	1158.123	484.356
519	1158.123	492.048
520	1158.123	497.048
521	1179.505	414.054
522	1179.505	420.785
523	1179.505	429.632
524	1179.505	440.595
525	1179.505	453.674
526	1179.505	469.445
527	1179.505	482.523
528	1179.505	492.909
529	1179.505	500.601
530	1179.505	505.601
531	1200.081	422.284
532	1200.081	429.015
533	1200.081	437.863
534	1200.081	448.825
535	1200.081	461.904
536	1200.081	477.675
537	1200.081	490.754
538	1200.081	501.139

539	1200.081	508.832
540	1200.081	513.832
541	1219.851	430.192
542	1219.851	436.923
543	1219.851	445.771
544	1219.851	456.733
545	1219.851	469.812
546	1219.851	485.583
547	1219.851	498.662
548	1219.851	509.047
549	1219.851	516.740
550	1219.851	521.740
551	1238.814	437.777
552	1238.814	444.509
553	1238.814	453.356
554	1238.814	464.318
555	1238.814	477.397
556	1238.814	493.168
557	1238.814	506.247
558	1238.814	516.632
559	1238.814	524.325
560	1238.814	529.325
561	1256.970	445.040
562	1256.970	451.771
563	1256.970	460.618
564	1256.970	471.581
565	1256.970	484.660
566	1256.970	500.431
567	1256.970	513.509
568	1256.970	523.895
569	1256.970	531.587
570	1256.970	536.587
571	1274.320	451.979
572	1274.320	458.711
573	1274.320	467.558
574	1274.320	478.521
575	1274.320	491.600
576	1274.320	507.371
577	1274.320	520.449
578	1274.320	530.834
579	1274.320	538.527
580	1274.320	543.527
581	1290.863	458.597
582	1290.863	465.328
583	1290.863	474.175
584	1290.863	485.138
585	1290.863	498.217
586	1290.863	513.988
587	1290.863	527.066
588	1290.863	537.452
589	1290.863	545.145
590	1290.863	550.145
591	1306.599	464.892
592	1306.599	471.623
593	1306.599	480.470
594	1306.599	491.433
595	1306.599	504.512
596	1306.599	520.283
597	1306.599	533.361
598	1306.599	543.747
599	1306.599	551.439
600	1306.599	556.439
601	1321.529	470.864
602	1321.529	477.595
603	1321.529	486.442
604	1321.529	497.405
605	1321.529	510.484
606	1321.529	526.255
607	1321.529	539.333
608	1321.529	549.719
609	1321.529	557.411
610	1321.529	562.411
611	1335.653	476.513
612	1335.653	483.244
613	1335.653	492.091
614	1335.653	503.054
615	1335.653	516.133
616	1335.653	531.904
617	1335.653	544.982
618	1335.653	555.368

619	1335.653	563.061
620	1335.653	568.061
621	1348.969	481.840
622	1348.969	488.571
623	1348.969	497.418
624	1348.969	508.381
625	1348.969	521.460
626	1348.969	537.231
627	1348.969	550.309
628	1348.969	560.695
629	1348.969	568.387
630	1348.969	573.387
631	1361.480	486.844
632	1361.480	493.575
633	1361.480	502.422
634	1361.480	513.385
635	1361.480	526.464
636	1361.480	542.235
637	1361.480	555.313
638	1361.480	565.699
639	1361.480	573.391
640	1361.480	578.391
641	1373.183	491.525
642	1373.183	498.256
643	1373.183	507.104
644	1373.183	518.066
645	1373.183	531.145
646	1373.183	546.916
647	1373.183	559.995
648	1373.183	570.380
649	1373.183	578.073
650	1373.183	583.073
651	1384.081	495.884
652	1384.081	502.615
653	1384.081	511.462
654	1384.081	522.425
655	1384.081	535.504
656	1384.081	551.275
657	1384.081	564.354
658	1384.081	574.739
659	1384.081	582.432
660	1384.081	587.432
661	1394.171	499.920
662	1394.171	506.651
663	1394.171	515.499
664	1394.171	526.461
665	1394.171	539.540
666	1394.171	555.311
667	1394.171	568.390
668	1394.171	578.775
669	1394.171	586.468
670	1394.171	591.468
671	1403.455	503.634
672	1403.455	510.365
673	1403.455	519.212
674	1403.455	530.175
675	1403.455	543.254
676	1403.455	559.025
677	1403.455	572.103
678	1403.455	582.489
679	1403.455	590.181
680	1403.455	595.181
681	1411.932	507.025
682	1411.932	513.756
683	1411.932	522.603
684	1411.932	533.566
685	1411.932	546.645
686	1411.932	562.416
687	1411.932	575.494
688	1411.932	585.880
689	1411.932	593.572
690	1411.932	598.572

CF. ... 9. ELEMENT DEFINITIONS. FORMAT (16I5) ...

1 1 11 12 2 1 9 68

```
CF.        ... 11. CARD INPUT FCR INITIAL CR PREINITIAL
                   CONDITIONS.  FCRMAT (I5,5X,F10.0)     ...

    1      C.
  690      C.


CF.        ... 12. STEADY-STATE INTEGER PARAMETERS.  FORMAT (16I5)  ...

    0    0    1    2   72   73


CF.        ... 13. STEADY-STATE RAINFALL PROFILES.  FORMAT (8F10.0)  ...

C.        1.
1C00000.  1000000.


CF.        ... 14. STEADY-STATE RAINFALL TYPES AND
                   PONDING DEPTHS.  FCRMAT (3I5,5X,2F10.0)  ...

    6    1    0     0.
   10    1    1     0.
  690    1   10     0.


CF.        ... 15. STEADY-STATE RAINFALL-SEEPAGE
                   SURFACE ELEMENTS.  FCRMAT (16I5)  ...

    6    6    7    0
    9    9   10    1
    9   10   20    0
  612  680  690    1


CF.        ... 18. TRANSIENT-STATE INTEGER PARAMETERS.  FORMAT (16I5)  ...

    0    C    1    2   72   73


CF.        ... 19. TRANSIENT-STATE RAINFALL PROFILES.  FORMAT (8F10.0)  ...

0.                  1.E50
C.        C.


CF.        ... 20. TRANSIENT-STATE RAINFALL TYPES AND
                   PONDING DEPTHS.  FCRMAT (3I5,5X,2F10.0)  ...

    6    1    0     0.
   10    1    1     0.
  690    1   10     0.


CF.        ... 21. TRANSIENT-STATE RAINFALL-SEEPAGE
                   SURFACE ELEMENTS.  FCRMAT (16I5)  ...

    6    6    7    0
    9    9   10    1
    9   1C   20    0
  612  680  690    1
```

PROBLEM 1273.. COWEETA PROBLEM

INPUT TABLE 1.. BASIC PARAMETERS

NUMBER OF NODAL POINTS.	650
NUMBER OF ELEMENTS.	612
NUMBER OF DIFFERENT MATERIALS	1
NUMBER OF CORRECTION MATERIALS.	0
NUMBER OF TIME INCREMENTS	50
STEADY-STATE I.C. CONTROL	0
SOIL-PROPERTY CONTROL	1
NUMBER OF SOIL PARAMETERS	43
AUXILIARY STORAGE CONTROL	0
CONDUCTIVITY-PERMEABILITY CONTROL . . .	0
GRAVITY CONTROL	0
RESTART PARAMETER	0
MAXIMUM ITERATIONS PER CYCLE.	25
MAXIMUM CYCLES PER TIME STEP.	3
TIME INCREMENT.	0.003300
MULTIPLIER FOR INCREASING DELT.	0.050000
MAXIMUM VALUE OF DELT	0.25000D 00
MAXIMUM VALUE OF TIME	0.10000D 51
DEGREES OF PRIN-AXIS INCLINATION. . . .	0.0
STEADY-STATE TOLERANCE.	0.010000
TRANSIENT-STATE TOLERANCE	0.010000
DENSITY OF WATER.	1.000000
ACCELERATION OF GRAVITY	980.600
VISCOSITY OF WATER.	0.013000
TIME-INTEGRATION PARAMETER.	1.000000

OUTPUT CONTROL
00000000000000000000000000000000000000000000000001

INPUT TABLE 2.. MATERIAL PROPERTIES

MAT. NO.	ALP	BETAP	POR	KX	KZ
1	0.0	0.0	0.50000 00	0.0	0.0

INPUT TABLE 3.. SOIL-PROPERTIES INTERPOLATION VALUES

MAT. NO.	PRESSURE	MOISTURE CONTENT	CONDUCTIVITY/PERMEABILITY	WATER CAPACITY
1	-0.1129D 05	0.1180D 00	0.4500D 03	0.3540D-05
	-0.9382D 04	0.1250D 00	-0.3000D 02	0.4270D-05
	-0.7736D 04	0.1330D 00	0.5000D 01	0.5170D-05
	-0.6409D 04	0.1400D 00	0.0	0.6250D-05
	-0.5292D 04	0.1480D 00	0.0	0.7560D-05
	-0.4381D 04	0.1560D 00	0.0	0.9140D-05
	-0.3627D 04	0.1630D 00	0.0	0.1100D-04
	-0.2983D 04	0.1710D 00	0.0	0.1340D-04
	-0.2476D 04	0.1780D 00	0.0	0.1620D-04
	-0.2053D 04	0.1860D 00	0.0	0.1950D-04
	-0.1695D 04	0.1940D 00	0.0	0.2360D-04
	-0.1403D 04	0.2010D 00	0.0	0.2850D-04
	-0.1156D 04	0.2090D 00	0.0	0.3460D-04
	-0.9585D 03	0.2160D 00	0.0	0.4180D-04
	-0.7946D 03	0.2240D 00	0.0	0.5040D-04
	-0.6542D 03	0.2320D 00	0.0	0.6120D-04
	-0.5426D 03	0.2390D 00	0.0	0.7380D-04
	-0.4492D 03	0.2470D 00	0.0	0.8910D-04
	-0.3712D 03	0.2540D 00	0.0	0.1080D-03
	-0.3070D 03	0.2620D 00	0.0	0.1300D-03
	-0.2526D 03	0.2700D 00	0.0	0.1580D-03
	-0.2096D 03	0.2770D 00	0.0	0.1910D-03
	-0.1740D 03	0.2850D 00	0.0	0.2300D-03
	-0.1500D 03	0.2910D 00	0.0	0.2700D-03
	-0.1250D 03	0.3003D 00	0.0	0.4750D-03
	-0.1000D 03	0.3151D 00	0.0	0.7230D-03
	-0.8500D 02	0.3273D 00	0.0	0.9050D-03
	-0.7000D 02	0.3425D 00	0.0	0.1130D-02
	-0.6000D 02	0.3547D 00	0.0	0.1310D-02
	-0.5000D 02	0.3691D 00	0.0	0.1700D-02
	-0.4000D 02	0.3863D 00	0.0	0.3740D-02
	-0.3500D 02	0.4087D 00	0.0	0.5440D-02
	-0.3000D 02	0.4373D 00	0.0	0.6160D-02
	-0.2500D 02	0.4668D 00	0.0	0.5440D-02
	-0.2000D 02	0.4910D 00	0.0	0.3740D-02
	-0.1000D 02	0.5110D 00	0.0	0.1300D-02
	0.0	0.5201D 00	0.0	0.7000D-03
	0.1000D 02	0.5263D 00	0.0	0.5400D-03
	0.2000D 02	0.5308D 00	0.0	0.4800D-03
	0.3000D 02	0.5353D 00	0.0	0.4200D-03
	0.4000D 02	0.5392D 00	0.0	0.3600D-03
	0.5000D 02	0.5425D 00	0.0	0.3000D-03
	0.6000D 02	0.5452D 00	0.0	0.2400D-03

INPUT TABLE 5.. NODAL POINT DATA

NODE	X	Z
1	0.0	0.0
2	0.0	0.6730D 01
3	0.0	0.2000D 02
4	0.0	0.3433D 02
5	0.0	0.4300D 02
6	0.0	0.4600D 02
7	0.0	0.4700D 02
8	0.0	0.4850D 02
9	0.0	0.5050D 02
10	0.0	0.5300D 02
11	0.2000D 01	0.0
12	0.2000D 01	0.6730D 01
13	0.2000D 01	0.2000D 02
14	0.2000D 01	0.3433D 02
15	0.2000D 01	0.4300D 02
16	0.2000D 01	0.4600D 02
17	0.2000D 01	0.4700D 02
18	0.2000D 01	0.4850D 02
19	0.2000D 01	0.5050D 02
20	0.2000D 01	0.5300D 02
21	0.5071D 01	0.0
22	0.5071D 01	0.6730D 01
23	0.5071D 01	0.2000D 02
24	0.5071D 01	0.3433D 02
25	0.5071D 01	0.4300D 02
26	0.5071D 01	0.4600D 02
27	0.5071D 01	0.4700D 02
28	0.5071D 01	0.4850D 02
29	0.5071D 01	0.5050D 02
30	0.5071D 01	0.5300D 02
31	0.9213D 01	0.0
32	0.9213D 01	0.6730D 01
33	0.9213D 01	0.2000D 02
34	0.9213D 01	0.3433D 02
35	0.9213D 01	0.4300D 02
36	0.9213D 01	0.4600D 02
37	0.9213D 01	0.4700D 02
38	0.9213D 01	0.4850D 02
39	0.9213D 01	0.5050D 02
40	0.9213D 01	0.5300D 02
41	0.1443D 02	0.0
42	0.1443D 02	0.6730D 01
43	0.1443D 02	0.2000D 02
44	0.1443D 02	0.3433D 02
45	0.1443D 02	0.4300D 02
46	0.1443D 02	0.4600D 02
47	0.1443D 02	0.4700D 02
48	0.1443D 02	0.4850D 02
49	0.1443D 02	0.5050D 02
50	0.1443D 02	0.5300D 02
51	0.2071D 02	0.0
52	0.2071D 02	0.6730D 01
53	0.2071D 02	0.2000D 02
54	0.2071D 02	0.3433D 02
55	0.2071D 02	0.4300D 02
56	0.2071D 02	0.4600D 02
57	0.2071D 02	0.4700D 02
58	0.2071D 02	0.4850D 02
59	0.2071D 02	0.5050D 02
60	0.2071D 02	0.5300D 02
61	0.2806D 02	0.0
62	0.2806D 02	0.6730D 01
63	0.2806D 02	0.2000D 02
64	0.2806D 02	0.3433D 02
65	0.2806D 02	0.4300D 02
66	0.2806D 02	0.4600D 02
67	0.2806D 02	0.4700D 02
68	0.2806D 02	0.4850D 02
69	0.2806D 02	0.5050D 02
70	0.2806D 02	0.5300D 02
71	0.3649D 02	0.0
72	0.3649D 02	0.6730D 01

73	0.3649D 02	0.2000D 02
74	0.3649D 02	0.3433D 02
75	0.3649D 02	0.4300D 02
76	0.3649D 02	0.4600D 02
77	0.3649D 02	0.4700D 02
78	0.3649D 02	0.4850D 02
79	0.3649D 02	0.5050D 02
80	0.3649D 02	0.5300D 02
81	0.4599D 02	0.0
82	0.4599D 02	0.6730D 01
83	0.4599D 02	0.2000D 02
84	0.4599D 02	0.3433D 02
85	0.4599D 02	0.4300D 02
86	0.4599D 02	0.4600D 02
87	0.4599D 02	0.4700D 02
88	0.4599D 02	0.4850D 02
89	0.4599D 02	0.5050D 02
90	0.4599D 02	0.5300D 02
91	0.5656D 02	0.0
92	0.5656D 02	0.6730D 01
93	0.5656D 02	0.2000D 02
94	0.5656D 02	0.3433D 02
95	0.5656D 02	0.4300D 02
96	0.5656D 02	0.4683D 02
97	0.5656D 02	0.4891D 02
98	0.5656D 02	0.5074D 02
99	0.5656D 02	0.5370D 02
100	0.5656D 02	0.5642D 02
101	0.6819D 02	0.0
102	0.6819D 02	0.6730D 01
103	0.6819D 02	0.2000D 02
104	0.6819D 02	0.3433D 02
105	0.6819D 02	0.4300D 02
106	0.6819D 02	0.4796D 02
107	0.6819D 02	0.5150D 02
108	0.6819D 02	0.5446D 02
109	0.6819D 02	0.5805D 02
110	0.6819D 02	0.6108D 02
111	0.8090D 02	0.0
112	0.8090D 02	0.6730D 01
113	0.8090D 02	0.2000D 02
114	0.8090D 02	0.3433D 02
115	0.8090D 02	0.4300D 02
116	0.8090D 02	0.4920D 02
117	0.8090D 02	0.5433D 02
118	0.8090D 02	0.5853D 02
119	0.8090D 02	0.6280D 02
120	0.8090D 02	0.6616D 02
121	0.9468D 02	0.0
122	0.9468D 02	0.6730D 01
123	0.9468D 02	0.2000D 02
124	0.9468D 02	0.3433D 02
125	0.9468D 02	0.4300D 02
126	0.9468D 02	0.5055D 02
127	0.9468D 02	0.5740D 02
128	0.9468D 02	0.6294D 02
129	0.9468D 02	0.6796D 02
130	0.9468D 02	0.7167D 02
131	0.1095D 03	0.0
132	0.1095D 03	0.6730D 01
133	0.1095D 03	0.2000D 02
134	0.1095D 03	0.3433D 02
135	0.1095D 03	0.4300D 02
136	0.1095D 03	0.5199D 02
137	0.1095D 03	0.6071D 02
138	0.1095D 03	0.6768D 02
139	0.1095D 03	0.7350D 02
140	0.1095D 03	0.7760D 02
141	0.1255D 03	0.0
142	0.1255D 03	0.6730D 01
143	0.1255D 03	0.2000D 02
144	0.1255D 03	0.3433D 02
145	0.1255D 03	0.4300D 02
146	0.1255D 03	0.5355D 02
147	0.1255D 03	0.6427D 02
148	0.1255D 03	0.7281D 02
149	0.1255D 03	0.7949D 02
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151	0.1425D 03	0.0

152	0.1425D 03	0.6730D 01
153	0.1425D 03	0.2000D 02
154	0.1425D 03	0.3433D 02
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157	0.1425D 03	0.6806D 02
158	0.1425D 03	0.7825D 02
159	0.1425D 03	0.8585D 02
160	0.1425D 03	0.9080D 02
161	0.1605D 03	0.6459D 01
162	0.1605D 03	0.1319D 02
163	0.1605D 03	0.2204D 02
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173	0.1797D 03	0.2969D 02
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233	0.3170D 03	0.8461D 02
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260	0.3713D 03	0.1823D 03
261	0.4001D 03	0.1023D 03
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264	0.4001D 03	0.1288D 03
265	0.4001D 03	0.1419D 03
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568	0.1257D 04	C.5239D 03
569	0.1257D 04	C.5316D 03
570	0.1257D 04	C.5366D 03
571	0.1274D 04	C.4520D 03
572	0.1274D 04	C.4587D 03
573	0.1274D 04	C.4676D 03
574	0.1274D 04	C.4785D 03
575	0.1274D 04	C.4916D 03
576	0.1274D 04	C.5074D 03
577	0.1274D 04	C.5204D 03
578	0.1274D 04	C.5308D 03
579	0.1274D 04	C.5385D 03
580	0.1274D 04	C.5435D 03
581	0.1291D 04	C.4586D 03
582	0.1291D 04	C.4653D 03
583	0.1291D 04	C.4742D 03
584	0.1291D 04	C.4851D 03
585	0.1291D 04	C.4982D 03
586	0.1291D 04	C.5140D 03
587	0.1291D 04	C.5271D 03
588	0.1291D 04	C.5375D 03
589	0.1291D 04	C.5451D 03
590	0.1291D 04	C.5501D 03
591	0.1307D 04	C.4649D 03
592	0.1307D 04	C.4716D 03
593	0.1307D 04	C.4805D 03
594	0.1307D 04	C.4914D 03
595	0.1307D 04	C.5045D 03
596	0.1307D 04	C.5203D 03
597	0.1307D 04	C.5334D 03
598	0.1307D 04	C.5437D 03
599	0.1307D 04	C.5514D 03
600	0.1307D 04	C.5564D 03
601	0.1322D 04	C.4709D 03
602	0.1322D 04	C.4776D 03
603	0.1322D 04	C.4864D 03
604	0.1322D 04	C.4974D 03
605	0.1322D 04	C.5105D 03
606	0.1322D 04	C.5263D 03
607	0.1322D 04	C.5393D 03
608	0.1322D 04	C.5497D 03
609	0.1322D 04	C.5574D 03
610	0.1322D 04	C.5624D 03
611	0.1336D 04	C.4765D 03
612	0.1336D 04	C.4832D 03
613	0.1336D 04	C.4921D 03
614	0.1336D 04	C.5031D 03
615	0.1336D 04	C.5161D 03
616	0.1336D 04	C.5319D 03
617	0.1336D 04	C.5450D 03
618	0.1336D 04	C.5554D 03
619	0.1336D 04	C.5631D 03
620	0.1336D 04	C.5681D 03
621	0.1349D 04	C.4818D 03
622	0.1349D 04	C.4886D 03
623	0.1349D 04	C.4974D 03
624	0.1349D 04	C.5084D 03
625	0.1349D 04	C.5215D 03
626	0.1349D 04	C.5372D 03
627	0.1349D 04	C.5503D 03
628	0.1349D 04	C.5607D 03

629	0.1349D 04	C.5684D 03
630	0.1349D 04	C.5734D 03
631	0.1361D 04	C.4868D 03
632	0.1361D 04	C.4936D 03
633	0.1361D 04	C.5024D 03
634	0.1361D 04	C.5134D 03
635	0.1361D 04	C.5265D 03
636	0.1361D 04	C.5422D 03
637	0.1361D 04	C.5553D 03
638	0.1361D 04	C.5657D 03
639	0.1361D 04	C.5734D 03
640	0.1361D 04	C.5784D 03
641	0.1373D 04	C.4915D 03
642	0.1373D 04	C.4983D 03
643	0.1373D 04	C.5071D 03
644	0.1373D 04	C.5181D 03
645	0.1373D 04	C.5311D 03
646	0.1373D 04	C.5469D 03
647	0.1373D 04	C.5600D 03
648	0.1373D 04	C.5704D 03
649	0.1373D 04	C.5781D 03
650	0.1373D 04	C.5831D 03
651	0.1384D 04	C.4959D 03
652	0.1384D 04	C.5026D 03
653	0.1384D 04	C.5115D 03
654	0.1384D 04	C.5224D 03
655	0.1384D 04	C.5355D 03
656	0.1384D 04	C.5513D 03
657	0.1384D 04	C.5644D 03
658	0.1384D 04	C.5747D 03
659	0.1384D 04	C.5824D 03
660	0.1384D 04	C.5874D 03
661	0.1394D 04	C.4999D 03
662	0.1394D 04	C.5067D 03
663	0.1394D 04	C.5155D 03
664	0.1394D 04	C.5265D 03
665	0.1394D 04	C.5395D 03
666	0.1394D 04	C.5553D 03
667	0.1394D 04	C.5684D 03
668	0.1394D 04	C.5788D 03
669	0.1394D 04	C.5865D 03
670	0.1394D 04	C.5915D 03
671	0.1403D 04	C.5036D 03
672	0.1403D 04	C.5104D 03
673	0.1403D 04	C.5192D 03
674	0.1403D 04	C.5302D 03
675	0.1403D 04	C.5433D 03
676	0.1403D 04	C.5590D 03
677	0.1403D 04	C.5721D 03
678	0.1403D 04	C.5825D 03
679	0.1403D 04	C.5902D 03
680	0.1403D 04	C.5952D 03
681	0.1412D 04	C.5070D 03
682	0.1412D 04	C.5138D 03
683	0.1412D 04	C.5226D 03
684	0.1412D 04	C.5336D 03
685	0.1412D 04	C.5466D 03
686	0.1412D 04	C.5624D 03
687	0.1412D 04	C.5755D 03
688	0.1412D 04	C.5859D 03
689	0.1412D 04	C.5936D 03
690	0.1412D 04	C.5986D 03

INPUT TABLE 6.. ELEMENT DATA

ELEMENT	GLOBAL INDICES OF ELEMENT NODES 1	2	3	4	MATERIAL	NODE DIFF
1	1	11	12	2	1	11
2	2	12	13	3	1	11
3	3	13	14	4	1	11
4	4	14	15	5	1	11
5	5	15	16	6	1	11
6	6	16	17	7	1	11
7	7	17	18	8	1	11
8	8	18	19	9	1	11
9	9	19	20	10	1	11
10	11	21	22	12	1	11
11	12	22	23	13	1	11
12	13	23	24	14	1	11
13	14	24	25	15	1	11
14	15	25	26	16	1	11
15	16	26	27	17	1	11
16	17	27	28	18	1	11
17	18	28	29	19	1	11
18	19	29	30	20	1	11
19	21	31	32	22	1	11
20	22	32	33	23	1	11
21	23	33	34	24	1	11
22	24	34	35	25	1	11
23	25	35	36	26	1	11
24	26	36	37	27	1	11
25	27	37	38	28	1	11
26	28	38	39	29	1	11
27	29	39	40	30	1	11
28	31	41	42	32	1	11
29	32	42	43	33	1	11
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32	35	45	46	36	1	11
33	36	46	47	37	1	11
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41	45	55	56	46	1	11
42	46	56	57	47	1	11
43	47	57	58	48	1	11
44	48	58	59	49	1	11
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47	52	62	63	53	1	11
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54	59	69	70	60	1	11
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62	68	78	79	69	1	11
63	69	79	80	70	1	11
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65	72	82	83	73	1	11
66	73	83	84	74	1	11
67	74	84	85	75	1	11
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72	79	89	90	80	1	11
73	81	91	92	82	1	11
74	82	92	93	83	1	11
75	83	93	94	84	1	11
76	84	94	95	85	1	11

77	85	95	96	86	1	11
78	86	96	97	87	1	11
79	87	97	98	88	1	11
80	88	98	99	89	1	11
81	89	99	100	90	1	11
82	91	101	102	92	1	11
83	92	102	103	93	1	11
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101	112	122	123	113	1	11
102	113	123	124	114	1	11
103	114	124	125	115	1	11
104	115	125	126	116	1	11
105	116	126	127	117	1	11
106	117	127	128	118	1	11
107	118	128	129	119	1	11
108	119	129	130	120	1	11
109	121	131	132	122	1	11
110	122	132	133	123	1	11
111	123	133	134	124	1	11
112	124	134	135	125	1	11
113	125	135	136	126	1	11
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115	127	137	138	128	1	11
116	128	138	139	129	1	11
117	129	139	140	130	1	11
118	131	141	142	132	1	11
119	132	142	143	133	1	11
120	133	143	144	134	1	11
121	134	144	145	135	1	11
122	135	145	146	136	1	11
123	136	146	147	137	1	11
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126	139	149	150	140	1	11
127	141	151	152	142	1	11
128	142	152	153	143	1	11
129	143	153	154	144	1	11
130	144	154	155	145	1	11
131	145	155	156	146	1	11
132	146	156	157	147	1	11
133	147	157	158	148	1	11
134	148	158	159	149	1	11
135	149	159	160	150	1	11
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138	153	163	164	154	1	11
139	154	164	165	155	1	11
140	155	165	166	156	1	11
141	156	166	167	157	1	11
142	157	167	168	158	1	11
143	158	168	169	159	1	11
144	159	169	170	160	1	11
145	161	171	172	162	1	11
146	162	172	173	163	1	11
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151	167	177	178	168	1	11
152	168	178	179	169	1	11
153	169	179	180	170	1	11
154	171	181	182	172	1	11
155	172	182	183	173	1	11
156	173	183	184	174	1	11

157	174	184	185	175	1	11
158	175	185	186	176	1	11
159	176	186	187	177	1	11
160	177	187	188	178	1	11
161	178	188	189	179	1	11
162	179	189	190	180	1	11
163	181	191	192	182	1	11
164	182	192	193	183	1	11
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166	184	194	195	185	1	11
167	185	195	196	186	1	11
168	186	196	197	187	1	11
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171	189	199	200	190	1	11
172	191	201	202	192	1	11
173	192	202	203	193	1	11
174	193	203	204	194	1	11
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186	206	216	217	207	1	11
187	207	217	218	208	1	11
188	208	218	219	209	1	11
189	209	219	220	210	1	11
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191	212	222	223	213	1	11
192	213	223	224	214	1	11
193	214	224	225	215	1	11
194	215	225	226	216	1	11
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198	219	229	230	220	1	11
199	221	231	232	222	1	11
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201	223	233	234	224	1	11
202	224	234	235	225	1	11
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204	226	236	237	227	1	11
205	227	237	238	228	1	11
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221	245	255	256	246	1	11
222	246	256	257	247	1	11
223	247	257	258	248	1	11
224	248	258	259	249	1	11
225	249	259	260	250	1	11
226	251	261	262	252	1	11
227	252	262	263	253	1	11
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229	254	264	265	255	1	11
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232	257	267	268	258	1	11
233	258	268	269	259	1	11
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235	261	271	272	262	1	11

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237	263	273	274	264	1	11
238	264	274	275	265	1	11
239	265	275	276	266	1	11
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241	267	277	278	268	1	11
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251	278	288	289	279	1	11
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257	285	295	296	286	1	11
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290	322	332	333	323	1	11
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402	446	456	457	447	1	11
403	447	457	458	448	1	11
404	448	458	459	449	1	11
405	449	459	460	450	1	11
406	451	461	462	452	1	11
407	452	462	463	453	1	11
408	453	463	464	454	1	11
409	454	464	465	455	1	11
410	455	465	466	456	1	11
411	456	466	467	457	1	11
412	457	467	468	458	1	11
413	458	468	469	459	1	11
414	459	469	470	460	1	11
415	461	471	472	462	1	11
416	462	472	473	463	1	11
417	463	473	474	464	1	11
418	464	474	475	465	1	11
419	465	475	476	466	1	11
420	466	476	477	467	1	11
421	467	477	478	468	1	11
422	468	478	479	469	1	11
423	469	479	480	470	1	11
424	471	481	482	472	1	11
425	472	482	483	473	1	11
426	473	483	484	474	1	11
427	474	484	485	475	1	11
428	475	485	486	476	1	11
429	476	486	487	477	1	11
430	477	487	488	478	1	11
431	478	488	489	479	1	11
432	479	489	490	480	1	11
433	481	491	492	482	1	11
434	482	492	493	483	1	11
435	483	493	494	484	1	11
436	484	494	495	485	1	11
437	485	495	496	486	1	11
438	486	496	497	487	1	11
439	487	497	498	488	1	11
440	488	498	499	489	1	11
441	489	499	500	490	1	11
442	491	501	502	492	1	11
443	492	502	503	493	1	11
444	493	503	504	494	1	11
445	494	504	505	495	1	11
446	495	505	506	496	1	11
447	496	506	507	497	1	11
448	497	507	508	498	1	11
449	498	508	509	499	1	11
450	499	509	510	500	1	11
451	501	511	512	502	1	11
452	502	512	513	503	1	11
453	503	513	514	504	1	11
454	504	514	515	505	1	11
455	505	515	516	506	1	11
456	506	516	517	507	1	11
457	507	517	518	508	1	11
458	508	518	519	509	1	11
459	509	519	520	510	1	11
460	511	521	522	512	1	11
461	512	522	523	513	1	11
462	513	523	524	514	1	11
463	514	524	525	515	1	11
464	515	525	526	516	1	11
465	516	526	527	517	1	11
466	517	527	528	518	1	11
467	518	528	529	519	1	11
468	519	529	530	520	1	11
469	521	531	532	522	1	11

470	522	532	533	523	1	11
471	523	533	534	524	1	11
472	524	534	535	525	1	11
473	525	535	536	526	1	11
474	526	536	537	527	1	11
475	527	537	538	528	1	11
476	528	538	539	529	1	11
477	529	539	540	530	1	11
478	531	541	542	532	1	11
479	532	542	543	533	1	11
480	533	543	544	534	1	11
481	534	544	545	535	1	11
482	535	545	546	536	1	11
483	536	546	547	537	1	11
484	537	547	548	538	1	11
485	538	548	549	539	1	11
486	539	549	550	540	1	11
487	541	551	552	542	1	11
488	542	552	553	543	1	11
489	543	553	554	544	1	11
490	544	554	555	545	1	11
491	545	555	556	546	1	11
492	546	556	557	547	1	11
493	547	557	558	548	1	11
494	548	558	559	549	1	11
495	549	559	560	550	1	11
496	551	561	562	552	1	11
497	552	562	563	553	1	11
498	553	563	564	554	1	11
499	554	564	565	555	1	11
500	555	565	566	556	1	11
501	556	566	567	557	1	11
502	557	567	568	558	1	11
503	558	568	569	559	1	11
504	559	569	570	560	1	11
505	561	571	572	562	1	11
506	562	572	573	563	1	11
507	563	573	574	564	1	11
508	564	574	575	565	1	11
509	565	575	576	566	1	11
510	566	576	577	567	1	11
511	567	577	578	568	1	11
512	568	578	579	569	1	11
513	569	579	580	570	1	11
514	571	581	582	572	1	11
515	572	582	583	573	1	11
516	573	583	584	574	1	11
517	574	584	585	575	1	11
518	575	585	586	576	1	11
519	576	586	587	577	1	11
520	577	587	588	578	1	11
521	578	588	589	579	1	11
522	579	589	590	580	1	11
523	581	591	592	582	1	11
524	582	592	593	583	1	11
525	583	593	594	584	1	11
526	584	594	595	585	1	11
527	585	595	596	586	1	11
528	586	596	597	587	1	11
529	587	597	598	588	1	11
530	588	598	599	589	1	11
531	589	599	600	590	1	11
532	591	601	602	592	1	11
533	592	602	603	593	1	11
534	593	603	604	594	1	11
535	594	604	605	595	1	11
536	595	605	606	596	1	11
537	596	606	607	597	1	11
538	597	607	608	598	1	11
539	598	608	609	599	1	11
540	599	609	610	600	1	11
541	601	611	612	602	1	11
542	602	612	613	603	1	11
543	603	613	614	604	1	11
544	604	614	615	605	1	11
545	605	615	616	606	1	11
546	606	616	617	607	1	11
547	607	617	618	608	1	11
548	608	618	619	609	1	11
549	609	619	620	610	1	11

550	611	621	622	612	1	11
551	612	622	623	613	1	11
552	613	623	624	614	1	11
553	614	624	625	615	1	11
554	615	625	626	616	1	11
555	616	626	627	617	1	11
556	617	627	628	618	1	11
557	618	628	629	619	1	11
558	619	629	630	620	1	11
559	621	631	632	622	1	11
560	622	632	633	623	1	11
561	623	633	634	624	1	11
562	624	634	635	625	1	11
563	625	635	636	626	1	11
564	626	636	637	627	1	11
565	627	637	638	628	1	11
566	628	638	639	629	1	11
567	629	639	640	630	1	11
568	631	641	642	632	1	11
569	632	642	643	633	1	11
570	633	643	644	634	1	11
571	634	644	645	635	1	11
572	635	645	646	636	1	11
573	636	646	647	637	1	11
574	637	647	648	638	1	11
575	638	648	649	639	1	11
576	639	649	650	640	1	11
577	641	651	652	642	1	11
578	642	652	653	643	1	11
579	643	653	654	644	1	11
580	644	654	655	645	1	11
581	645	655	656	646	1	11
582	646	656	657	647	1	11
583	647	657	658	648	1	11
584	648	658	659	649	1	11
585	649	659	660	650	1	11
586	651	661	662	652	1	11
587	652	662	663	653	1	11
588	653	663	664	654	1	11
589	654	664	665	655	1	11
590	655	665	666	656	1	11
591	656	666	667	657	1	11
592	657	667	668	658	1	11
593	658	668	669	659	1	11
594	659	669	670	660	1	11
595	661	671	672	662	1	11
596	662	672	673	663	1	11
597	663	673	674	664	1	11
598	664	674	675	665	1	11
599	665	675	676	666	1	11
600	666	676	677	667	1	11
601	667	677	678	668	1	11
602	668	678	679	669	1	11
603	669	679	680	670	1	11
604	671	681	682	672	1	11
605	672	682	683	673	1	11
606	673	683	684	674	1	11
607	674	684	685	675	1	11
608	675	685	686	676	1	11
609	676	686	687	677	1	11
610	677	687	688	678	1	11
611	678	688	689	679	1	11
612	679	689	690	680	1	11

INPUT TABLE 7.. STEADY-STATE B.C. PARAMETERS

NUMBER OF BOUNDARY CONDITIONS	0
NUMBER OF SURFACE TERMS	0
NUMBER OF RAINFALL PROFILES	1
NUMBER OF RAINFALL PARAMETERS	2
NUMBER OF RAINFALL-SEEPAGE ELEMENTS . .	72
NUMBER OF RAINFALL-SEEPAGE NODES. . . .	73

INPUT TABLE 11.. RAINFALL DATA

PROFILE 1

TIME	RATE
0.0	1.0000D 06
1.0000D 00	1.0000D 06

INPUT TABLE 12.. RAINFALL DISTRIBUTION AND PONDING

NODE	TYPE	DEPTH
6	1	0.0
7	1	0.0
8	1	0.0
9	1	0.0
10	1	0.0
20	1	0.0
30	1	0.0
40	1	0.0
50	1	0.0
60	1	0.0
70	1	0.0
80	1	0.0
90	1	0.0
100	1	0.0
110	1	0.0
120	1	0.0
130	1	0.0
140	1	0.0
150	1	0.0
160	1	0.0
170	1	0.0
180	1	0.0
190	1	0.0
200	1	0.0
210	1	0.0
220	1	0.0
230	1	0.0
240	1	0.0
250	1	0.0
260	1	0.0
270	1	0.0
280	1	0.0
290	1	0.0
300	1	0.0
310	1	0.0
320	1	0.0
330	1	0.0
340	1	0.0
350	1	0.0
360	1	0.0
370	1	0.0
380	1	0.0
390	1	0.0
400	1	0.0
410	1	0.0
420	1	0.0
430	1	0.0
440	1	0.0
450	1	0.0
460	1	0.0
470	1	0.0
480	1	0.0
490	1	0.0
500	1	0.0
510	1	0.0
520	1	0.0
530	1	0.0
540	1	0.0
550	1	0.0
560	1	0.0
570	1	0.0
580	1	0.0
590	1	0.0
600	1	0.0
610	1	0.0
620	1	0.0
630	1	0.0
640	1	0.0
650	1	0.0
660	1	0.0
670	1	0.0
680	1	0.0
690	1	0.0

INPUT TABLE 13.. RAINFALL-SEEPAGE SURFACE INFORMATION

ELEMENT	NODE 1	NODE 2
6	6	7
7	7	8
8	8	9
9	9	10
9	10	20
18	20	30
27	30	40
36	40	50
45	50	60
54	60	70
63	70	80
72	80	90
81	90	100
90	100	110
99	110	120
108	120	130
117	130	140
126	140	150
135	150	160
144	160	170
153	170	180
162	180	190
171	190	200
180	200	210
189	210	220
198	220	230
207	230	240
216	240	250
225	250	260
234	260	270
243	270	280
252	280	290
261	290	300
270	300	310
279	310	320
288	320	330
297	330	340
306	340	350
315	350	360
324	360	370
333	370	380
342	380	390
351	390	400
360	400	410
369	410	420
378	420	430
387	430	440
396	440	450
405	450	460
414	460	470
423	470	480
432	480	490
441	490	500
450	500	510
459	510	520
468	520	530
477	530	540
486	540	550
495	550	560
504	560	570
513	570	580
522	580	590
531	590	600
540	600	610
549	610	620
558	620	630
567	630	640
576	640	650
585	650	660
594	660	670
603	670	680
612	680	690

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DIAGNOSTIC TABLE 1.. AT TIME = C.0 .(DELT = 3.3000D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NC. NCN-CCNV. NODES
1	C.8513D C2	-C.1000D 01	617
2	C.0	C.0	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1526D 05	0.0	0.0
RAINFALL.	-0.1557D C5	0.0	0.0
NUMERICAL LOSSES.	-0.4866D C3	0.0	0.0
NET FLOW.	-0.7963D 03	0.0	0.0
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.0	0.0	0.6739D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1156D 04	0.6850D 03	0.5977D 03	0.3659D 03	-0.3357D 03	-0.7654D 03	-0.5765D 03	-C.2585D C3
0.2060D 02	0.2592D C3	0.5212D 03	0.9875D 03	0.2034C 04	0.1889D 04	0.1423C C4	C.1138D 04
C.9509D 03	C.7929D C3	C.6470D 03	0.5111D 03	0.3903D 03	0.2871D 03	0.204CD C3	C.1407D C3
0.9465D 02	0.62C9D C2	C.3981D 02	0.2461D 02	0.1529D 02	0.8883D 01	0.5275D C1	C.3153D C1
0.1558D C1	C.7913D 00	C.3803D 00	0.4046D 00	0.2587D 00	0.1724D 0C	-0.6761D-C1	-C.1458D C0
-0.1906D 00	0.5478D-C1	0.1677D-01	0.6744D-01	-0.2782D 00	-0.3278D 00	-0.4047D 0C	-C.8329D 00
-0.1396D 01	-0.2495C C1	-C.4233D 01	-0.6655D 01	-0.1023C 02	-0.1578D 02	-0.2475D C2	-0.3676D C2
-0.5418D 02	-C.7888D C2	-C.1124D 03	-0.1571D 03	-0.2155D 03	-0.2904D 03	-0.3846D C3	-C.4991C C3
-0.6353D 03	-C.7930D C3	-C.9698D 03	-0.1162D 04	-0.1367C 04	-0.1583D 04	-0.1816D C4	-C.2110D C4
-0.1298D 04							

INPUT TABLE 10.. TRANSIENT B.C. PARAMETERS

NUMBER OF BOUNDARY CONDITIONS	0
NUMBER OF SURFACE TERMS	0
NUMBER OF RAINFALL PROFILES	1
NUMBER OF RAINFALL PARAMETERS	2
NUMBER OF RAINFALL-SEEPAGE ELEMENTS . .	72
NUMBER OF RAINFALL-SEEPAGE NODES. . . .	73

INPUT TABLE 11.. RAINFALL DATA

PROFILE 1

TIME	RATE
0.0	C.0
1.0000D 50	C.0

INPUT TABLE 12.. RAINFALL DISTRIBUTION AND PONDING

NODE	TYPE	DEPTH
6	1	0.0
7	1	0.0
8	1	0.0
9	1	0.0
10	1	0.0
20	1	0.0
30	1	0.0
40	1	0.0
50	1	0.0
60	1	0.0
70	1	0.0
80	1	0.0
90	1	0.0
100	1	0.0
110	1	0.0
120	1	0.0
130	1	0.0
140	1	0.0
150	1	0.0
160	1	0.0
170	1	0.0
180	1	0.0
190	1	0.0
200	1	0.0
210	1	0.0
220	1	0.0
230	1	0.0
240	1	0.0
250	1	0.0
260	1	0.0
270	1	0.0
280	1	0.0
290	1	0.0
300	1	0.0
310	1	0.0
320	1	0.0
330	1	0.0
340	1	0.0
350	1	0.0
360	1	0.0
370	1	0.0
380	1	0.0
390	1	0.0
400	1	0.0
410	1	0.0
420	1	0.0
430	1	0.0
440	1	0.0
450	1	0.0
460	1	0.0
470	1	0.0
480	1	0.0
490	1	0.0
500	1	0.0
510	1	0.0
520	1	0.0
530	1	0.0
540	1	0.0
550	1	0.0
560	1	0.0
570	1	0.0
580	1	0.0
590	1	0.0
600	1	0.0
610	1	0.0
620	1	0.0
630	1	0.0
640	1	0.0
650	1	0.0
660	1	0.0
670	1	0.0
680	1	0.0
690	1	0.0

INPUT TABLE 13.. RAINFALL-SEEPAGE SURFACE INFORMATION

ELEMENT	NODE 1	NODE 2
6	6	7
7	7	8
8	8	9
9	9	10
9	10	20
18	20	30
27	30	40
36	40	50
45	50	60
54	60	70
63	70	80
72	80	90
81	90	100
90	100	110
99	110	120
108	120	130
117	130	140
126	140	150
135	150	160
144	160	170
153	170	180
162	180	190
171	190	200
180	200	210
189	210	220
198	220	230
207	230	240
216	240	250
225	250	260
234	260	270
243	270	280
252	280	290
261	290	300
270	300	310
279	310	320
288	320	330
297	330	340
306	340	350
315	350	360
324	360	370
333	370	380
342	380	390
351	390	400
360	400	410
369	410	420
378	420	430
387	430	440
396	440	450
405	450	460
414	460	470
423	470	480
432	480	490
441	490	500
450	500	510
459	510	520
468	520	530
477	530	540
486	540	550
495	550	560
504	560	570
513	570	580
522	580	590
531	590	600
540	600	610
549	610	620
558	620	630
567	630	640
576	640	650
585	650	660
594	660	670
603	670	680
612	680	690

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DIAGNOSTIC TABLE 2.. AT TIME = 3.3000D-03 .(DELT = 3.3000D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NC. NCN-CCNV. NCDES
1	0.1350C-12	C.3975D-14	0
2	C.2487C-13	C.5357D-15	0
3	C.2839D C2	C.1897D 02	377
4	C.1314D C2	C.9070D 01	234
5	C.8198D 01	C.1187D 02	218
6	0.5088D C1	C.7933D 01	206
7	C.3221C 01	C.1908D 02	195
8	C.2038D 01	C.7911D 01	183
9	0.1292D 01	C.9566D 00	171
10	C.8011D 00	C.7836D 00	157
11	C.4979D CC	C.2694D 00	144
12	0.3093C CC	C.2288D 00	127
13	0.1913D CC	C.1150D 00	113
14	C.1186D 00	C.8053D-01	94
15	C.7336D-C1	C.4611D-01	74
16	C.4544D-C1	C.2994D-01	49
17	C.2813D-C1	C.1799D-01	23
18	0.1742D-C1	C.1135D-01	12
19	C.1078D-C1	C.6946D-02	2
20	C.6676D-C2	C.4331D-02	0
21	C.8048C C1	C.6434D 01	329
22	C.1314C C2	C.9070D 01	234
23	0.8198D 01	C.1187D 02	218
24	C.5088D C1	C.7933D 01	206
25	C.3221D C1	C.1908D 02	195
26	C.2038C C1	C.7911D 01	183
27	C.1292C 01	C.9566D 00	171
28	0.8011D 0C	C.7836D 00	157
29	C.4979D CC	C.2694D 00	144
30	C.3093D CC	C.2288D 00	127
31	C.1913D CC	C.1150D 00	113
32	C.1186C C0	C.8053D-01	94
33	C.7336D-C1	C.4611D-01	74
34	C.4544D-01	C.2994D-01	49
35	C.2813D-C1	C.1799D-01	23
36	C.1742C-01	C.1135D-01	12
37	C.1078C-C1	C.6946D-02	2
38	0.6676D-C2	C.4331D-02	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLCW	TCTAL FLOW
CONSTANT-PRESSURE-NODE FLCW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	C.0
SEEPAGE	0.1394D C5	0.4599C 02	0.4599D 02
RAINFALL	-0.1554D C4	-0.5129C 01	-0.5129D 01
NUMERICAL LOSSES.	-0.65CCD 03	-0.2145C 01	-0.2145D 01
NET FLOW.	0.1173D C5	0.3871C 02	0.3871D 02
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1121D C5	-0.3700D 02	0.6735D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9634D 03	0.4902D 03	0.2665D 03	0.1131D 03	-0.8894D 00	-0.7647D 02	-0.2329D 02	0.2542D 02
0.3735D 02	0.8947D 02	0.4231D 03	0.5395D 03	0.2003D 04	0.1871D 04	0.1412D 04	0.1131D 04
0.9469D 03	0.7903D 03	0.6452D 03	0.5100D 03	0.3896D 03	0.2867D 03	0.2037D 03	0.1405D 03
0.9454D 02	0.6203D 02	0.3978D 02	0.2460D 02	0.1528D 02	0.8878D 01	0.5272D 01	0.3152D 01
0.1557D 01	0.7900D 00	0.3775D 00	0.3573D 00	0.2337D 00	0.1092D 00	0.3932D-02	-0.1013D-01
-0.1309D-01	-0.8943D-02	-0.1124D-01	-0.1942D-01	-0.4303D-01	-0.7461D-01	-0.1036D 00	-0.1655D 00
-0.2631D 00	-0.4038D 00	-0.6193D 00	-0.9164D 00	-0.1326D 01	-0.1895D 01	-0.2725D 01	-0.3838D 01
-0.5312D 01	-0.7335D 01	-0.9994D 01	-0.1347D 02	-0.1799D 02	-0.2381D 02	-0.3132D 02	-0.4080D 02
-0.5252D 02	-0.6670D 02	-0.8408D 02	-0.1081D 03	-0.1408D 03	-0.1783D 03	-0.2155D 03	-0.2500D 03
-0.1948D 03							

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DIAGNOSTIC TABLE 3.. AT TIME = 6.7650D-03 .(DELT = 3.4650D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.1113D 02	0.1526D 02	400
2	0.4992D 01	0.1613D 02	228
3	0.1811D 01	0.6822D 01	195
4	0.7094D 00	0.4346D 00	166
5	0.2645D 00	0.2794D 00	135
6	0.9958D-01	0.8133D-01	100
7	0.3650D-01	0.3256D-01	50
8	0.1340D-01	0.1161D-01	8
9	0.4926D-02	0.4320D-02	0
10	0.3697D 01	0.3736D 01	224
11	0.4992D 01	0.1613D 02	228
12	0.1811D 01	0.6822D 01	195
13	0.7094D 00	0.4346D 00	166
14	0.2645D 00	0.2794D 00	135
15	0.9958D-01	0.8133D-01	100
16	0.3650D-01	0.3256D-01	50
17	0.1340D-01	0.1161D-01	8
18	0.4926D-02	0.4320D-02	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1384D 05	0.4812D 02	0.9410D 02
RAINFALL.	-0.1225D 04	-0.4814D 01	-0.9944D 01
NUMERICAL LOSSES.	-0.5261D 03	-0.2038D 01	-0.4183D 01
NET FLOW.	0.1209D 05	0.4126D 02	0.7998D 02
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1153D 05	-0.3996D 02	0.6731D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9543D 03	0.4828D 03	0.2573D 03	0.1098D 03	-0.1222D-01	-0.7344D 02	-0.2164D 02	0.2616D 02
0.3577D 02	0.7417D 02	0.4105D 03	0.9299D 03	0.1994D 04	0.1865D 04	0.1408D 04	0.1128D 04
0.9445D 03	0.7885D 03	0.6439D 03	0.5090D 03	0.3689D 03	0.2862D 03	0.2034D 03	0.1403D 03
0.9440D 02	0.6194D 02	0.3972D 02	0.2456D 02	0.1526D 02	0.8868D 01	0.5266D 01	0.3148D 01
0.1553D 01	0.7836D 00	0.3640D 00	0.3587D 00	0.1284D 00	0.4921D-02	-0.6550D-02	-0.1662D-01
-0.2776D-01	-0.3628D-01	-0.5462D-01	-0.8460D-01	-0.1369D 00	-0.2122D 00	-0.3018D 00	-0.4461D 00
-0.6405D 00	-0.9062D 00	-0.1274D 01	-0.1751D 01	-0.2365D 01	-0.3151D 01	-0.4197D 01	-0.5493D 01
-0.7092D 01	-0.9131D 01	-0.1165D 02	-0.1477D 02	-0.1862D 02	-0.2334D 02	-0.2905D 02	-0.3628D 02
-0.4707D 02	-0.6262D 02	-0.8085D 02	-0.9952D 02	-0.1182D 03	-0.1353D 03	-0.1492D 03	-0.1548D 03
-0.1109D 03							

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DIAGNOSTIC TABLE 4.. AT TIME = 1.0403D-02 .(DELT = 3.6382D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.6639D 01	0.9933D 01	342
2	0.2173D 01	0.3145D 01	229
3	0.5451D 00	0.4985D 01	178
4	0.1416D 00	0.2034D 00	133
5	0.3579D-01	0.6256D-01	72
6	0.9134D-02	0.1464D-01	0
7	0.1743D 01	0.3452D 01	226
8	0.2173D 01	0.3145D 01	229
9	0.5451D 00	0.4985D 01	178
10	0.1416D 00	0.2034D 00	133
11	0.3579D-01	0.6256D-01	72
12	0.9134D-02	0.1464D-01	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1382D 05	0.5031D 02	0.1444D 03
RAINFALL.	-0.1137D 04	-0.4297D 01	-0.1424D 02
NUMERICAL LOSSES.	-0.4177D 03	-0.1717D 01	-0.5899D 01
NET FLOW.	0.1226D 05	0.4429D 02	0.1243D 03
INCREASE IN VOLUMETRIC WATER CONTENT. . .	-0.1189D 05	-0.4327D 02	0.6727D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9533D 03	0.4821D 03	0.2566D 03	0.1095D 03	-0.4661D-03	-0.7331D 02	-0.2164D 02	0.2609D 02
0.3548D 02	0.7223D 02	0.4086D 03	0.9281D 03	0.1992D 04	0.1863D 04	0.1407D 04	0.1127D 04
0.9436D 03	0.7878D 03	0.6433D 03	0.5086D 03	0.3886D 03	0.2859D 03	0.2032D 03	0.1402D 03
0.9429D 02	0.6187D 02	0.3967D 02	0.2453D 02	0.1524D 02	0.8855D 01	0.5258D 01	0.3139D 01
0.1539D 01	0.7551D 00	0.2911D 00	0.1660D 00	0.9733D-02	-0.1215D-01	-0.2341D-01	-0.4376D-01
-0.6916D-01	-0.9870D-01	-0.1461D 00	-0.2156D 00	-0.3206D 00	-0.4651D 00	-0.6429D 00	-0.8973D 00
-0.1226D 01	-0.1651D 01	-0.2205D 01	-0.2896D 01	-0.3747D 01	-0.4786D 01	-0.6096D 01	-0.7660D 01
-0.9517D 01	-0.1181D 02	-0.1455D 02	-0.1780D 02	-0.2160D 02	-0.2631D 02	-0.3350D 02	-0.4405D 02
-0.5647D 02	-0.6945D 02	-0.8290D 02	-0.9601D 02	-0.1078D 03	-0.1160D 03	-0.1173D 03	-0.1111D 03
-0.7309D 02							

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DIAGNOSTIC TABLE 5.. AT TIME = 1.4223D-02 .(DELT = 3.8202D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.4840D 01	0.1456D 02	335
2	0.1144D 01	0.2038D 01	234
3	0.2189D 00	0.8796D 00	170
4	0.4127D-01	0.8796D-01	104
5	0.7804D-02	0.1807D-01	0
6	0.9626D 00	0.2339D 01	232
7	0.1144D 01	0.2038D 01	234
8	0.2189D 00	0.8796D 00	170
9	0.4127D-01	0.8796D-01	104
10	0.7804D-02	0.1807D-01	0
11	0.9626D 00	0.2339D 01	232
12	0.1144D 01	0.2038D 01	234
13	0.2189D 00	0.8796D 00	170
14	0.4127D-01	0.8796D-01	104
15	0.7804D-02	0.1807D-01	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1381D 05	0.5278D 02	0.1972D 03
RAINFALL.	-0.1064D 04	-0.4204D 01	-0.1844D 02
NUMERICAL LOSSES.	-0.3410D 03	-0.1449D 01	-0.7348D 01
NET FLOW.	0.1241D 05	0.4712D 02	0.1714D 03
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1221D 05	-0.4665D 02	0.6722D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9532D 03	0.4820D 03	0.2565D 03	0.1095D 03	0.2323D-03	-0.7329D 02	-0.2164D 02	0.2608D 02
0.3543D 02	0.7191D 02	0.4082D 03	0.9277D 03	0.1992D 04	0.1863D 04	0.1407D 04	0.1127D 04
0.9434D 03	0.7876D 03	0.6431D 03	0.5084D 03	0.3884D 03	0.2858D 03	0.2031D 03	0.1401D 03
0.9423D 02	0.6183D 02	0.3964D 02	0.2451D 02	0.1523D 02	0.8842D 01	0.5241D 01	0.3112D 01
0.1482D 01	0.6150D 00	0.3719D-01	-0.9279D-02	-0.1601D-01	-0.3560D-01	-0.6034D-01	-0.9745D-01
-0.1467D 00	-0.2082D 00	-0.2975D 00	-0.4206D 00	-0.5927D 00	-0.8191D 00	-0.1095D 01	-0.1464D 01
-0.1924D 01	-0.2497D 01	-0.3213D 01	-0.4074D 01	-0.5102D 01	-0.6321D 01	-0.7805D 01	-0.9541D 01
-0.1158D 02	-0.1401D 02	-0.1680D 02	-0.1993D 02	-0.2414D 02	-0.3156D 02	-0.4069D 02	-0.5047D 02
-0.6057D 02	-0.7091D 02	-0.8130D 02	-0.8997D 02	-0.9503D 02	-0.9588D 02	-0.9108D 02	-0.7959D 02
-0.4956D 02							

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DIAGNOSTIC TABLE 6.. AT TIME = 1.8235D-02 .(DELT = 4.0112D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.3924D 01	0.1346D 02	351
2	0.6843D 00	0.1161D 02	238
3	0.9529D-01	0.1815D 00	161
4	0.1447D-01	0.3096D-01	37
5	0.2074D-02	0.4197D-02	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1381D 05	0.5540D 02	0.2526D 03
RAINFALL.	-0.9974D 03	-0.4134D 01	-0.2258D 02
NUMERICAL LOSSES.	-0.2654D 03	-0.1216D 01	-0.8565D 01
NET FLOW.	0.1255D 05	0.5005D 02	0.2214D 03
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1240D 05	-0.4975D 02	0.6717D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9532D 03	0.4820D 03	0.2564D 03	0.1094D 03	0.3283D-03	-0.7329D 02	-0.2164D 02	0.2608D 02
0.3542D 02	0.7184D 02	0.4081D 03	0.9277D 03	0.1992D 04	0.1863D 04	0.1406D 04	0.1127D 04
0.9433D 03	0.7875D 03	0.6431D 03	0.5083D 03	0.3884D 03	0.2858D 03	0.2030D 03	0.1401D 03
0.9421D 02	0.6181D 02	0.3963D 02	0.2450D 02	0.1521D 02	0.8817D 01	0.5197D 01	0.3023D 01
0.1260D 01	0.9164D-01	-0.1738D-01	-0.2533D-01	-0.4865D-01	-0.7939D-01	-0.1231D 00	-0.1850D 00
-0.2666D 00	-0.3689D 00	-0.5087D 00	-0.6927D 00	-0.9366D 00	-0.1246D 01	-0.1616D 01	-0.2089D 01
-0.2661D 01	-0.3351D 01	-0.4186D 01	-0.5168D 01	-0.6311D 01	-0.7636D 01	-0.9232D 01	-0.1108D 02
-0.1318D 02	-0.1558D 02	-0.1843D 02	-0.2279D 02	-0.2927D 02	-0.3684D 02	-0.4478D 02	-0.5304D 02
-0.6135D 02	-0.6976D 02	-0.7703D 02	-0.8102D 02	-0.8203D 02	-0.7811D 02	-0.6978D 02	-0.5752D 02
-0.3412D 02							

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DIAGNOSTIC TABLE 7.. AT TIME = 2.2446D-02 .(DELT = 4.2117D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.3406D 01	0.2022D 02	367
2	0.4668D 00	0.1392D 01	245
3	0.5334D-01	0.1411D 01	156
4	0.6368D-02	0.3804D 00	0
5	0.4204D 00	0.4350D 02	244
6	0.4668D 00	0.1392D 01	245
7	0.5334D-01	0.1411D 01	156
8	0.6368D-02	0.3804D 00	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1381D 05	0.5816D 02	0.3108D 03
RAINFALL.	-0.9349D 03	-0.4069D 01	-0.2665D 02
NUMERICAL LOSSES.	-0.2119D 03	-0.1005D 01	-0.9570D 01
NET FLOW.	0.1266D 05	0.5309D 02	0.2745D 03
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1255D 05	-0.5286D 02	0.6712D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9531D 03	0.4820D 03	0.2564D 03	0.1094D 03	0.3446D-03	-0.7329D 02	-0.2164D 02	0.2607D 02
0.3542D 02	0.7183D 02	0.4081D 03	0.9276D 03	0.1992D 04	0.1863D 04	0.1406D 04	0.1127D 04
0.9433D 03	0.7875D 03	0.6431D 03	0.5083D 03	0.3884D 03	0.2857D 03	0.2030D 03	0.1400D 03
0.9420D 02	0.6179D 02	0.3961D 02	0.2448D 02	0.1517D 02	0.8752D 01	0.5066D 01	0.2705D 01
0.5241D 00	-0.1623D-03	-0.3266D-01	-0.6162D-01	-0.9727D-01	-0.1478D 00	-0.2159D 00	-0.3089D 00
-0.4286D 00	-0.5766D 00	-0.7699D 00	-0.1015D 01	-0.1328D 01	-0.1713D 01	-0.2165D 01	-0.2722D 01
-0.3380D 01	-0.4157D 01	-0.5075D 01	-0.6132D 01	-0.7348D 01	-0.8756D 01	-0.1042D 02	-0.1228D 02
-0.1431D 02	-0.1686D 02	-0.2107D 02	-0.2670D 02	-0.3307D 02	-0.3964D 02	-0.4655D 02	-0.5354D 02
-0.6049D 02	-0.6668D 02	-0.7040D 02	-0.7185D 02	-0.6879D 02	-0.6239D 02	-0.5285D 02	-0.4143D 02
-0.2419D 02							

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DIAGNOSTIC TAPLE 8.. AT TIME = 2.6669D-02 .(DELT = 4.4223C-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NC. NCN-CCNV. NCDES
1	C.3090D C1	C.3788D 03	380
2	C.3544D CC	C.1946D 01	253
3	C.3509C-C1	C.5546D 00	151
4	C.3659D-C2	0.3563D-01	0
5	C.3236D 0C	C.3381D 01	250
6	0.3544C CC	C.1946D 01	253
7	C.35C9D-C1	C.5546D 00	151
8	C.3659D-C2	C.3563D-01	0

TABLE OF SYSTEM-FLCW PARAMETERS

TYPE OF FLOW	RATE	INC. FLCW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLCW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1381D 05	C.6106C 02	0.3718D 03
RAINFALL.	-0.8764C 03	-0.4005C 01	-0.3065D 02
NUMERICAL LOSSES.	-0.17CCD 03	-0.8445C 00	-0.1041D 02
NET FLCW.	0.1276D 05	0.5622C 02	C.3308D 03
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1266C 05	-0.5607C 02	C.6706D 05

RAINFALL-SEEPAGE NODAL FLCWS

0.9531D 03	C.4820D 03	0.2564D 03	0.1094D 03	0.3475D-03	-0.7329D 02	-0.2164D 02	C.2607D C2
0.3542D 02	0.7183D C2	C.4081D 03	C.9276D C3	0.1992C 04	0.1863D 04	0.14C6C C4	C.1127D C4
0.9433D 03	C.7875D C3	C.6431D 03	C.5C83D C3	0.3884D 03	0.2857D 03	0.203CD C3	C.1400D 03
0.9418D 02	C.6178D C2	C.3959D 02	0.2443D C2	0.1509D 02	C.8578D 01	0.4667D 01	C.1792D C1
0.1030D 0C	-C.4341D-C1	-C.6443D-01	-0.1127D 0C	-0.1677D 00	-C.2424D 00	-0.3392D CC	-C.4671C C0
-0.6273D 00	-C.8218D 0C	-C.1067D 01	-0.1370D C1	-0.1744D 01	-C.2194D 01	-0.27C9D C1	-C.3332D C1
-0.4054D 01	-0.4889C C1	-C.5859D 01	-0.6970D 01	-0.8248C 01	-0.9702D 01	-C.1135C C2	-C.1312D C2
-0.1535C 02	-0.1924C C2	-C.2418D 02	-0.2959D C2	-0.3515C 02	-0.4094D 02	-0.4685C C2	-C.5277D 02
-0.5818D 02	-0.6173C C2	-C.6358D 02	-0.6144D C2	-0.5647D 02	-0.4868D 02	-0.3943D C2	-C.3068D 02
-0.1768D 02							

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DIAGNOSTIC TABLE 9.. AT TIME = 3.1512D-02 .(DELT = 4.6434D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	C.2871D C1	C.3372D 02	394
2	C.2824D OC	C.1246D 01	256
3	C.2540D-C1	C.4490D 00	146
4	C.2304D-02	C.6990D-01	0
5	C.2593D OC	C.7897D 01	256
6	C.2824D OC	0.1246D 01	256
7	0.2540D-C1	C.4490D 00	146
8	C.23C4D-C2	C.6990D-01	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.138CD C5	0.6410C 02	0.4359D 03
RAINFALL.	-0.8229C 03	-0.3945C 01	-0.3460D 02
NUMERICAL LOSSES.	-0.1295D 03	-C.6955C CO	-0.1111D 02
NET FLOW.	0.1285D 05	0.5946C 02	C.3902C 03
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1273C 05	-0.5910C 02	0.6700C 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9531D 03	C.4820D 03	C.2564D 03	0.1C94D 03	0.3481D-03	-C.7329D 02	-0.2164D 02	C.2607D C2
0.3542D 02	0.7183D C2	C.4081D 03	C.9276D 03	0.1992D 04	0.1863D 04	0.14C6D C4	C.1127D C4
0.9433D 03	0.7875D C3	C.6431D 03	C.5083D 03	0.3883C 03	0.2857D 03	0.203CD C3	C.14C0D C3
0.9417D 02	C.6175D C2	C.3953D 02	0.2433D 02	0.1489D 02	0.8181D 01	0.3753D 01	C.2877D CC
-0.4437D-01	-C.6050D-01	-C.1156D 00	-0.18C1D OC	-0.2604D 00	-0.3622D 00	-0.490CD 00	-C.6538D CC
-0.8541D 00	-C.1093D C1	-C.1385D 01	-0.1738D 01	-0.2164D 01	-0.2664D 01	-0.3231D C1	-C.3902D C1
-0.4667D 01	-C.5539C 01	-C.6553D 01	-C.7713C C1	-0.9022D 01	-0.1045D 02	-0.1201C 02	-C.1399D C2
-0.1746D 02	-C.2180D C2	-C.2648D 02	-C.3126C 02	-0.3618D 02	-0.4115D 02	-0.4629C C2	-C.512CD C2
-0.5452D 02	-0.5662D 02	-C.5542D 02	-0.5162D 02	-0.4521D 02	-0.3737C 02	-0.30C9C 02	-C.2304D C2
-0.1312D 02							

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DIAGNOSTIC TABLE 10.. AT TIME = 3.6388D-02 .(DELT = 4.8756D-03)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.2712D 01	0.8931D 02	406
2	0.2323D 00	0.2404D 01	264
3	0.1946D-01	0.1867D 00	130
4	0.1773D-02	0.1368D-01	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1380D 05	0.6729D 02	0.5032D 03
RAINFALL.	-0.7745D 03	-0.3894D 01	-0.3849D 02
NUMERICAL LOSSES.	-0.9157D 02	-0.5390D 00	-0.1165D 02
NET FLOW.	0.1253D 05	0.6286D 02	0.4531D 03
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1274D 05	-0.6211D 02	0.6694D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9531D 03	0.4820D 03	0.2564D 03	0.1094D 03	0.3482D-03	-0.7329D 02	-0.2164D 02	0.2607D 02
0.3542D 02	0.7183D 02	0.4081D 03	0.9276D 03	0.1992D 04	0.1863D 04	0.1406D 04	0.1127D 04
0.9433D 03	0.7875D 03	0.6431D 03	0.5083D 03	0.3883D 03	0.2857D 03	0.2030D 03	0.1400D 03
0.9413D 02	0.6168D 02	0.3941D 02	0.2411D 02	0.1447D 02	0.7224D 01	0.1637D 01	0.6728D-01
-0.5776D-01	-0.1146D 00	-0.1751D 00	-0.2673D 00	-0.3739D 00	-0.5044D 00	-0.6632D 00	-0.8619D 00
-0.1100D 01	-0.1378D 01	-0.1712D 01	-0.2106D 01	-0.2573D 01	-0.3113D 01	-0.3718D 01	-0.4422D 01
-0.5216D 01	-0.6125D 01	-0.7180D 01	-0.8364D 01	-0.9643D 01	-0.1099D 02	-0.1274D 02	-0.1584D 02
-0.1962D 02	-0.2372D 02	-0.2788D 02	-0.3211D 02	-0.3632D 02	-0.4078D 02	-0.4514D 02	-0.4836D 02
-0.5067D 02	-0.5037D 02	-0.4755D 02	-0.4235D 02	-0.3562D 02	-0.2926D 02	-0.2322D 02	-0.1746D 02
-0.9915D 01							

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DIAGNOSTIC TABLE 5C.. AT TIME = 6.5481D-01 .(DELT = 3.4324D-02)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	C.28C5D 01	C.3257D 02	585
2	C.33C1D CC	C.2634D 00	469
3	0.3387D-C1	C.1249D-01	151
4	C.7828D-02	C.1923D-02	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1163D 05	0.4015D 03	0.8379D 04
RAINFALL.	-0.1717D 03	-0.5943C 01	-0.2210D 03
NUMERICAL LOSSES.	0.2292C 03	0.7835C 01	0.1061D 03
NET FLOW.	0.1165D 05	0.4034D 03	0.8264D 04
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1096C 05	-0.3762C 03	0.5955D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9501D 03	0.4798D 03	C.2540D 03	0.1085D 03	0.3210D-03	-0.7294D 02	-0.2176D C2	C.2573D C2
0.3416D 02	0.6366D 02	C.3977D 03	0.9134D 03	0.1969D 04	C.1830D 04	0.1363D 04	C.1066D C4
0.8573D 03	C.66C7D 03	C.4385D 03	0.1472D C3	0.1982C 02	C.5403D 01	0.2669C 01	C.8392C CC
0.7284D-01	-C.3132D 0C	-0.4418D 00	-0.4152D C0	-0.2296C 00	0.2949D 00	0.1358D C1	C.31C8D 01
0.5363D 01	0.7521D C1	C.8767D 01	0.8787D 01	0.6341C 01	0.2850D 01	-0.2081D-C1	-C.19C1D C1
-0.2965D 01	-C.3450D C1	-C.3484D 01	-0.3325D 01	-0.3435D 01	-0.3640C 01	-0.3834D 01	-C.3934D C1
-0.3930D 01	-C.3886D C1	-C.3762D 01	-0.3549C 01	-0.3320D 01	-0.3079D 01	-0.282CD 01	-C.2561D C1
-0.2318D 01	-0.2094C 01	-C.1683D 01	-C.1689D 01	-0.1513C 01	-0.1353D 01	-0.12C9D C1	-C.1081D C1
-0.9687D 00	-0.8688D CC	-C.7792D 00	-0.6973D 00	-0.6209D 00	-0.5469D 00	-0.4722D 0C	-C.3930D 00
-0.2462D 00							

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DIAGNOSTIC TABLE 51.. AT TIME = 6.9085D-01 .(DELT = 3.6040D-02)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.2861D 01	0.7361D 01	588
2	0.3388D 00	0.4307D 00	489
3	0.3796D-01	0.3187D-01	159
4	0.9423D-02	0.1937D-02	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.0	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1149D 05	0.4167D 03	0.8795D 04
RAINFALL.	-0.1692D 03	-0.6143D 01	-0.2271D 03
NUMERICAL LOSSES.	0.2310D 03	0.8294D 01	0.1144D 03
NET FLOW.	0.1155D 05	0.4189D 03	0.8682D 04
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.1083D 05	-0.3903D 03	0.5916D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.9497D 03	0.4795D 03	0.2537D 03	0.1084D 03	0.3205D-03	-0.7290D 02	-0.2177D 02	0.2569D 02
0.3400D 02	0.6263D 02	0.3964D 03	0.9117D 03	0.1966D 04	0.1826D 04	0.1357D 04	0.1059D 04
0.8462D 03	0.6440D 03	0.4090D 03	0.9155D 02	0.1164D 02	0.5847D 01	0.2235D 01	0.7825D 00
0.2753D-01	-0.2881D 00	-0.3417D 00	-0.2299D 00	0.1971D 00	0.1133D 01	0.2759D 01	0.5084D 01
0.7561D 01	0.9435D 01	0.9797D 01	0.8283D 01	0.5242D 01	0.1524D 01	-0.8849D 00	-0.2281D 01
-0.3060D 01	-0.3260D 01	-0.3137D 01	-0.3310D 01	-0.3538D 01	-0.3757D 01	-0.3891D 01	-0.3903D 01
-0.3876D 01	-0.3774D 01	-0.3574D 01	-0.3353D 01	-0.3120D 01	-0.2866D 01	-0.2608D 01	-0.2366D 01
-0.2140D 01	-0.1928D 01	-0.1732D 01	-0.1552D 01	-0.1389D 01	-0.1243D 01	-0.1112D 01	-0.9970D 00
-0.8951D 00	-0.8042D 00	-0.7224D 00	-0.6477D 00	-0.5774D 00	-0.5089D 00	-0.4394D 00	-0.3658D 00
-0.2297D 00							

OUTPUT

OUTPUT TABLE 1.. PRESSURE HEADS AT TIME = 6.9085D-01 ,(DELT = 3.6040D-02),(BAND WIDTH = 23)

NODE I	PRESSURE HEAD OF NODES I,I+1,....,I+7							
1	5.5668D 01	4.8838D 01	3.4765D 01	1.8470D 01	7.1538D 00	0.0	0.0	0.0
9	-1.2238D 00	-3.4917D 00	5.5675D 01	4.8849D 01	3.4788D 01	1.8516D 01	7.1433D 00	2.9434D 00
17	1.8097D 00	5.3053D-01	-1.0549D 00	-3.3676D 00	5.5723D 01	4.8894D 01	3.4850D 01	1.8585D 01
25	7.8997D 00	4.3857D 00	3.2852D 00	1.6868D 00	-3.3285D-01	-2.8115D 00	5.5849D 01	4.9023D 01
33	3.4988D 01	1.8869D 01	8.8158D 00	5.4726D 00	4.3845D 00	2.7826D 00	6.9188D-01	-1.8463D 00
41	5.6113D 01	4.9289D 01	3.5275D 01	1.9373D 01	9.6854D 00	6.4257D 00	5.3573D 00	3.7731D 00
49	1.6981D 00	-8.4590D-01	5.6579D 01	4.9758D 01	3.5780D 01	2.0035D 01	1.0464D 01	7.2158D 00
57	6.1471D 00	4.5609D 00	2.4874D 00	0.0	5.7325D 01	5.0509D 01	3.6567D 01	2.0850D 01
65	1.1155D 01	7.8006D 00	6.6851D 00	5.0158D 00	2.7929D 00	0.0	5.8435D 01	5.1623D 01
73	3.7711D 01	2.1929D 01	1.1935D 01	8.3817D 00	7.1880D 00	5.3868D 00	2.9817D 00	0.0
81	5.9991D 01	5.3186D 01	3.9312D 01	2.3521D 01	1.3329D 01	9.5892D 00	8.3036D 00	6.3439D 00
89	3.6205D 00	0.0	6.2072D 01	5.5277D 01	4.1480D 01	2.5883D 01	1.6004D 01	1.1503D 01
97	9.0098D 00	6.8071D 00	3.2338D 00	0.0	6.4727D 01	5.7947D 01	4.4281D 01	2.9066D 01
105	1.9665D 01	1.4234D 01	1.0348D 01	7.1096D 00	3.2323D 00	0.0	6.7960D 01	6.1200D 01
113	4.7699D 01	3.2896D 01	2.3883D 01	1.7428D 01	1.2105D 01	7.7754D 00	3.4089D 00	0.0
121	7.1706D 01	6.4965D 01	5.1627D 01	3.7178D 01	2.8453D 01	2.0875D 01	1.4039D 01	8.5512D 00
129	3.6188D 00	0.0	7.5817D 01	6.9104D 01	5.5911D 01	4.1761D 01	3.3263D 01	2.4500D 01
137	1.6069D 01	9.3915D 00	3.8647D 00	0.0	8.0166D 01	7.3436D 01	6.0425D 01	4.6578D 01
145	3.8281D 01	2.8259D 01	1.8184D 01	1.0253D 01	4.1138D 00	0.0	8.4047D 01	7.7603D 01
153	6.5008D 01	5.1508D 01	4.3397D 01	3.2066D 01	2.0269D 01	1.1062D 01	4.3144D 00	0.0
161	8.1991D 01	7.5889D 01	6.7824D 01	5.6563D 01	4.5809D 01	3.1467D 01	1.9696D 01	1.0444D 01
169	3.6445D 00	-7.6475D-01	8.0003D 01	7.3976D 01	6.6027D 01	5.6162D 01	4.4394D 01	3.0253D 01
177	1.8592D 01	9.3733D 00	2.5645D 00	-1.8526D 00	7.8287D 01	7.2295D 01	6.4409D 01	5.4629D 01
185	4.2964D 01	2.8923D 01	1.7306D 01	8.0998D 00	1.2887D 00	-3.1356D 00	7.6674D 01	7.0699D 01
193	6.2841D 01	5.3103D 01	4.1485D 01	2.7487D 01	1.5889D 01	6.6879D 00	-1.2512D-01	-4.5521D 00
201	7.5071D 01	6.9103D 01	6.1258D 01	5.1536D 01	3.9938D 01	2.5957D 01	1.4368D 01	5.1674D 00
209	-1.6459D 00	-6.0746D 00	7.3428D 01	6.7462D 01	5.9622D 01	4.9906D 01	3.8316D 01	2.4341D 01
217	1.2754D 01	3.5532D 00	-3.2623D 00	-7.6922D 00	7.1718D 01	6.5753D 01	5.7913D 01	4.8199D 01
225	3.6609D 01	2.2636D 01	1.1048D 01	1.8465D 00	-4.9704D 00	-9.4016D 00	6.9928D 01	6.3962D 01
233	5.6122D 01	4.6406D 01	3.4816D 01	2.0841D 01	9.2513D 00	4.6614D-02	-6.7723D 00	-1.1205D 01
241	6.8049D 01	6.2083D 01	5.4240D 01	4.4523D 01	3.2930D 01	1.8951D 01	7.3584D 00	-1.8493D 00
249	-8.6700D 00	-1.3104D 01	6.6076D 01	6.0107D 01	5.2263D 01	4.2542D 01	3.0946D 01	1.6962D 01
257	5.3651D 00	-3.8467D 00	-1.0672D 01	-1.5108D 01	6.4001D 01	5.8030D 01	5.0182D 01	4.0458D 01
265	2.8857D 01	1.4867D 01	3.2641D 00	-5.9532D 00	-1.2782D 01	-1.7221D 01	6.1819D 01	5.5846D 01
273	4.7995D 01	3.8266D 01	2.6660D 01	1.2662D 01	1.0503D 00	-8.1746D 00	-1.5009D 01	-1.9451D 01
281	5.9526D 01	5.3550D 01	4.5696D 01	3.5962D 01	2.4348D 01	1.0341D 01	-1.2801D 00	-1.0514D 01
289	-1.7357D 01	-2.1802D 01	5.7117D 01	5.1138D 01	4.3280D 01	3.3541D 01	2.1920D 01	7.9025D 00
297	-3.7286D 00	-1.2973D 01	-1.9823D 01	-2.4271D 01	5.4591D 01	4.8609D 01	4.0747D 01	3.1003D 01
305	1.9375D 01	5.3461D 00	-6.2958D 00	-1.5550D 01	-2.2406D 01	-2.6857D 01	5.1945D 01	4.5961D 01
313	3.8095D 01	2.8345D 01	1.6710D 01	2.6714D 00	-8.9809D 00	-1.8243D 01	-2.5102D 01	-2.9553D 01
321	4.8911D 01	4.2923D 01	3.5054D 01	2.5300D 01	1.3658D 01	-3.8847D-01	-1.2049D 01	-2.1317D 01
329	-2.8177D 01	-3.2629D 01	4.5984D 01	3.9994D 01	3.2120D 01	2.2362D 01	1.0715D 01	-3.3379D 00
337	-1.5004D 01	-2.4273D 01	-3.1131D 01	-3.5582D 01	4.3075D 01	3.7083D 01	2.9205D 01	1.9442D 01
345	7.7894D 00	-6.2708D 00	-1.7942D 01	-2.7212D 01	-3.4065D 01	-3.8518D 01	4.0179D 01	3.4183D 01
353	2.6301D 01	1.6531D 01	4.8721D 00	-9.1970D 00	-2.0874D 01	-3.0138D 01	-3.6987D 01	-4.1440D 01
361	3.7288D 01	3.1287D 01	2.3399D 01	1.3623D 01	1.9572D 00	-1.2120D 01	-2.3802D 01	-3.3063D 01
369	-3.9908D 01	-4.4361D 01	3.4394D 01	2.8387D 01	2.0492D 01	1.0709D 01	-9.6550D-01	-1.5052D 01
377	-2.6739D 01	-3.5992D 01	-4.2831D 01	-4.7284D 01	3.1486D 01	2.5473D 01	1.7570D 01	7.7777D 00
385	-3.9090D 00	-1.8009D 01	-2.9695D 01	-3.8943D 01	-4.5778D 01	-5.0234D 01	2.8558D 01	2.2538D 01
393	1.4626D 01	4.8218D 00	-6.8796D 00	-2.0996D 01	-3.2678D 01	-4.1914D 01	-4.8741D 01	-5.3195D 01
401	2.5608D 01	1.9581D 01	1.1660D 01	1.8433D 00	-9.8726D 00	-2.4003D 01	-3.5676D 01	-4.4892D 01
409	-5.1704D 01	-5.6155D 01	2.2635D 01	1.6601D 01	8.6700D 00	-1.1577D 00	-1.2886D 01	-2.7030D 01
417	-3.8699D 01	-4.7888D 01	-5.4672D 01	-5.9117D 01	1.9634D 01	1.3591D 01	5.6490D 00	-4.1917D 00
425	-1.5935D 01	-3.0082D 01	-4.1735D 01	-5.0890D 01	-5.7637D 01	-6.2073D 01	1.6598D 01	1.0544D 01
433	2.5890D 00	-7.2679D 00	-1.9030D 01	-3.3174D 01	-4.4790D 01	-5.3877D 01	-6.0579D 01	-6.5004D 01
441	1.3524D 01	7.4594D 00	-5.0960D-01	-1.0385D 01	-2.2168D 01	-3.6304D 01	-4.7867D 01	-5.6866D 01
449	-6.3505D 01	-6.7916D 01	1.0419D 01	4.3451D 00	-3.6376D 00	-1.3533D 01	-2.5333D 01	-3.9461D 01
457	-5.0947D 01	-5.9831D 01	-6.6395D 01	-7.0788D 01	7.2886D 00	1.2041D 00	-6.7932D 00	-1.6706D 01

465	-2.8514D 01	-4.2609D 01	-5.3969D 01	-6.2716D 01	-6.9204D 01	-7.3580D 01	4.1391D 00	-1.9563D 00
473	-9.9690D 00	-1.9897D 01	-3.1699D 01	-4.5736D 01	-5.6939D 01	-6.5532D 01	-7.1939D 01	-7.6297D 01
481	9.7793D-01	-5.1280D 00	-1.3155D 01	-2.3097D 01	-3.4886D 01	-4.8843D 01	-5.9861D 01	-6.8276D 01
489	-7.4594D 01	-7.8932D 01	-2.1888D 00	-8.3059D 00	-1.6347D 01	-2.6299D 01	-3.8067D 01	-5.1897D 01
497	-6.2684D 01	-7.0917D 01	-7.7151D 01	-8.1470D 01	-5.3518D 00	-1.1480D 01	-1.9533D 01	-2.9483D 01
505	-4.1208D 01	-5.4856D 01	-6.5388D 01	-7.3445D 01	-7.9601D 01	-8.3904D 01	-8.4969D 00	-1.4634D 01
513	-2.2695D 01	-3.2631D 01	-4.4286D 01	-5.7714D 01	-6.7979D 01	-7.5863D 01	-8.1945D 01	-8.6230D 01
521	-1.1609D 01	-1.7753D 01	-2.5816D 01	-3.5728D 01	-4.7294D 01	-6.0469D 01	-7.0455D 01	-7.8170D 01
529	-8.4181D 01	-8.8452D 01	-1.4665D 01	-2.0814D 01	-2.8872D 01	-3.8750D 01	-5.0205D 01	-6.3089D 01
537	-7.2797D 01	-8.0359D 01	-8.6309D 01	-9.0566D 01	-1.7639D 01	-2.3787D 01	-3.1831D 01	-4.1656D 01
545	-5.2958D 01	-6.5541D 01	-7.5005D 01	-8.2434D 01	-8.8330D 01	-9.2575D 01	-2.0504D 01	-2.6650D 01
553	-3.4669D 01	-4.4427D 01	-5.5561D 01	-6.7850D 01	-7.7091D 01	-8.4402D 01	-9.0252D 01	-9.4487D 01
561	-2.3246D 01	-2.9385D 01	-3.7382D 01	-4.7071D 01	-5.8032D 01	-7.0031D 01	-7.9067D 01	-8.6274D 01
569	-9.2083D 01	-9.6310D 01	-2.5858D 01	-3.1992D 01	-3.9966D 01	-4.9585D 01	-6.0371D 01	-7.2093D 01
577	-8.0944D 01	-8.8057D 01	-9.3832D 01	-9.8054D 01	-2.8342D 01	-3.4471D 01	-4.2419D 01	-5.1960D 01
585	-6.2576D 01	-7.4050D 01	-8.2737D 01	-8.9767D 01	-9.5513D 01	-9.9731D 01	-3.0715D 01	-3.6842D 01
593	-4.4767D 01	-5.4229D 01	-6.4682D 01	-7.5927D 01	-8.4462D 01	-9.1415D 01	-9.7134D 01	-1.0135D 02
601	-3.3002D 01	-3.9133D 01	-4.7040D 01	-5.6427D 01	-6.6720D 01	-7.7745D 01	-8.6134D 01	-9.3015D 01
609	-9.8710D 01	-1.0292D 02	-3.5229D 01	-4.1368D 01	-4.9265D 01	-5.8580D 01	-6.8718D 01	-7.9525D 01
617	-8.7769D 01	-9.4580D 01	-1.0025D 02	-1.0447D 02	-3.7423D 01	-4.3576D 01	-5.1464D 01	-6.0712D 01
625	-7.0697D 01	-8.1286D 01	-8.9384D 01	-9.6125D 01	-1.0178D 02	-1.0600D 02	-3.9612D 01	-4.5786D 01
633	-5.3669D 01	-6.2851D 01	-7.2681D 01	-8.3045D 01	-9.0993D 01	-9.7667D 01	-1.0330D 02	-1.0753D 02
641	-4.1827D 01	-4.8032D 01	-5.5919D 01	-6.5030D 01	-7.4691D 01	-8.4812D 01	-9.2613D 01	-9.9231D 01
649	-1.0486D 02	-1.0911D 02	-4.4102D 01	-5.0350D 01	-5.8245D 01	-6.7276D 01	-7.6733D 01	-8.6590D 01
657	-9.4261D 01	-1.0085D 02	-1.0650D 02	-1.1078D 02	-4.6474D 01	-5.2778D 01	-6.0686D 01	-6.9595D 01
665	-7.8794D 01	-8.8381D 01	-9.5965D 01	-1.0258D 02	-1.0830D 02	-1.1263D 02	-4.8999D 01	-5.5387D 01
673	-6.3257D 01	-7.1952D 01	-8.0839D 01	-9.0189D 01	-9.7763D 01	-1.0449D 02	-1.1035D 02	-1.1480D 02
681	-5.1830D 01	-5.8223D 01	-6.5897D 01	-7.4272D 01	-8.2835D 01	-9.2017D 01	-9.9687D 01	-1.0668D 02
689	-1.1284D 02	-1.1745D 02						

APPENDIX B

INPUT AND OUTPUT FOR FREEZE PROBLEM

INPUT

```
CF.        ... 1.  TITLE.  FORMAT (I5,9A8)*  ...

 0773 FREEZE TRANSIENT PROBLEM, MESH MODIFICATION


CF.        ... 2.  BASIC INTEGER PARAMETERS.  FORMAT (16I5)  ...

  434  390    1    0   70    0    1   16    0    1    0    0   25    3


CF.        ... 3.  BASIC REAL PARAMETERS.  FORMAT (8F10.0)  ...

.1        .5        200.      C.        C.        .01       .1        1.
580.6     .013      .5


CF.        ... 4.  PRINTER OUTPUT CONTROL.  FORMAT (80I1)  ...

C000000000CCCCOCOCOC0000000000000C000CCCCCOOCCCCOOCCOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO2


CF.        ... 5.  MATERIAL PROPERTIES.  FORMAT (8F10.0)  ...

C.        C.        .3                  .58E-7    .58E-7


CF.        ... 7.  SOIL PROPERTIES IN TABULAR FORM.  FORMAT (8F10.0)  ...

-800.     -400.     -200.     -175.     -150.     -125.     -100.     -62.5
-50.      -37.5     -25.      -12.5     0.        50.       100.      2000.
.024      .032      .0425     .C45      .050      .0625     .09       .21
.25       .275      .285      .290      .2925     .2975     .2995     .3
    .44E-8    .52E-8    .65E-8    .70E-8    .80E-8    .95E-8    .16E-7    .40E-7
    .48E-7    .53E-7    .55E-7    .56E-7    .56E-7    .57E-7    .58E-7    .58E-7
    0.        .52E-4    .10E-3    .20E-3    .50E-3    .11E-2    .32E-2    .32E-2
    .20E-2    .80E-3    .40E-3    .20E-3    .10E-3    .40E-4    .26E-6    0.
```

* COMMENT CARDS ARE TO BE DELETED FROM DATA SET. THEY ARE INCLUDED HERE AS A CROSS REFERENCE TO APPENDIX E.

CF. ... 8. NODAL-POINT PCSITIONS. FCRMAT (I5,2F10.3) ...

1	0.0	0.0
2	C.0	17.500
3	C.0	33.750
4	C.0	48.750
5	0.0	62.500
6	C.0	75.000
7	C.C	86.250
8	C.0	96.250
9	C.0	105.000
10	C.0	112.500
11	C.0	118.750
12	C.C	123.750
13	C.0	127.500
14	C.0	130.000
15	25.CCO	0.0
16	25.0CC	17.500
17	25.0CC	33.750
18	25.000	48.750
19	25.0CC	62.500
20	25.0CC	75.000
21	25.0CO	86.250
22	25.CCC	96.250
23	25.0CO	105.000
24	25.0CC	112.500
25	25.0CO	118.750
26	25.0CC	123.750
27	25.0CC	127.500
28	25.0CO	130.000
29	5C.CCO	0.0
30	5C.0CO	17.500
31	5C.0CO	33.750
32	5C.CCO	48.750
33	5C.0CO	62.500
34	5C.CCO	75.000
35	5C.0CO	86.250
36	5C.0CO	96.250
37	5C.0CO	105.000
38	5C.0CO	112.500
39	5C.0CO	118.750
40	50.0CO	123.750
41	5C.0CO	127.500
42	5C.CCO	130.000
43	75.0CC	0.0
44	75.CCO	17.500
45	75.CCO	33.750
46	75.0CC	48.750
47	75.0CO	62.500
48	75.0CO	75.000
49	75.0CC	86.250
50	75.0CO	96.250
51	75.0CO	105.000
52	75.CCO	112.500
53	75.0CO	118.750
54	75.0CO	123.750
55	75.0CO	127.500
56	75.CCC	130.000
57	1CC.CCC	0.0
58	100.0CO	17.500
59	1CO.CCO	33.750
60	1CC.0CO	48.750
61	1CC.CCC	62.500
62	1CC.CCC	75.000
63	1CC.0CO	86.250
64	1CO.000	96.250
65	1CC.000	105.000
66	1CC.0CO	112.500
67	1CC.CCO	118.750
68	1CC.0CO	123.750
69	100.0CO	127.500
70	1CC.0CO	130.000
71	11C.0CO	0.0
72	11C.CCO	19.038
73	11C.CCO	36.699
74	11C.0CO	52.961
75	11C.000	67.885
76	11C.CCO	81.410
77	11C.0CO	93.558
78	110.0CO	104.327

79	110.000	113.718
80	110.000	121.731
81	110.000	128.365
82	110.000	133.622
83	110.000	137.500
84	110.000	140.000
85	120.000	0.0
86	120.000	20.577
87	120.000	39.647
88	120.000	57.211
89	120.000	73.269
90	120.000	87.820
91	120.000	100.865
92	120.000	112.403
93	120.000	122.435
94	120.000	130.961
95	120.000	137.980
96	120.000	143.493
97	120.000	147.499
98	120.000	150.000
99	130.000	0.0
100	130.000	22.115
101	130.000	42.596
102	130.000	61.442
103	130.000	78.654
104	130.000	94.230
105	130.000	108.173
106	130.000	120.480
107	130.000	131.153
108	130.000	140.192
109	130.000	147.595
110	130.000	153.365
111	130.000	157.499
112	130.000	160.000
113	140.000	0.0
114	140.000	23.654
115	140.000	45.545
116	140.000	65.673
117	140.000	84.038
118	140.000	100.641
119	140.000	115.480
120	140.000	128.557
121	140.000	139.871
122	140.000	149.422
123	140.000	157.211
124	140.000	163.236
125	140.000	167.499
126	140.000	170.000
127	150.000	0.0
128	150.000	25.192
129	150.000	48.494
130	150.000	69.904
131	150.000	89.423
132	150.000	107.051
133	150.000	122.788
134	150.000	136.634
135	150.000	148.589
136	150.000	158.653
137	150.000	166.826
138	150.000	173.108
139	150.000	177.499
140	150.000	180.000
141	160.000	0.0
142	160.000	26.731
143	160.000	51.442
144	160.000	74.135
145	160.000	94.808
146	160.000	113.461
147	160.000	130.096
148	160.000	144.711
149	160.000	157.307
150	160.000	167.884
151	160.000	176.442
152	160.000	182.980
153	160.000	187.499
154	160.000	190.000
155	170.000	0.0
156	170.000	28.269
157	170.000	54.391
158	170.000	78.365

159	170.000	100.192
160	170.000	119.872
161	170.000	137.404
162	170.000	152.788
163	170.000	166.025
164	170.000	177.115
165	170.000	186.057
166	170.000	192.852
167	170.000	197.499
168	170.000	200.000
169	180.000	0.0
170	180.000	29.808
171	180.000	57.340
172	180.000	82.596
173	180.000	105.577
174	180.000	126.282
175	180.000	144.711
176	180.000	160.865
177	180.000	174.743
178	180.000	186.346
179	180.000	195.672
180	180.000	202.724
181	180.000	207.499
182	180.000	210.000
183	190.000	0.0
184	190.000	31.346
185	190.000	60.288
186	190.000	86.827
187	190.000	110.961
188	190.000	132.692
189	190.000	152.019
190	190.000	168.942
191	190.000	183.461
192	190.000	195.576
193	190.000	205.288
194	190.000	212.595
195	190.000	217.499
196	190.000	220.000
197	200.000	0.0
198	200.000	32.885
199	200.000	63.237
200	200.000	91.058
201	200.000	116.346
202	200.000	139.102
203	200.000	159.327
204	200.000	177.019
205	200.000	192.179
206	200.000	204.807
207	200.000	214.903
208	200.000	222.467
209	200.000	227.499
210	200.000	230.000
211	225.000	0.0
212	225.000	34.423
213	225.000	66.186
214	225.000	95.288
215	225.000	121.731
216	225.000	145.513
217	225.000	166.634
218	225.000	185.096
219	225.000	200.897
220	225.000	214.038
221	225.000	224.519
222	225.000	232.339
223	225.000	237.499
224	225.000	240.000
225	250.000	0.0
226	250.000	35.962
227	250.000	69.135
228	250.000	99.519
229	250.000	127.115
230	250.000	151.923
231	250.000	173.942
232	250.000	193.173
233	250.000	209.615
234	250.000	223.269
235	250.000	234.134
236	250.000	242.211
237	250.000	247.499
238	250.000	250.000
239	275.000	0.0
240	275.000	37.500

241	275.0C0	72.083
242	275.CC0	103.750
243	275.CCC	132.500
244	275.CCC	158.333
245	275.0C0	181.250
246	275.0C0	201.250
247	275.0C0	218.333
248	275.CCC	232.500
249	275.0CC	243.750
250	275.0CC	252.083
251	275.0C0	257.500
252	275.CCC	260.000
253	3CC.CCC	0.0
254	3CC.0C0	39.038
255	3CC.0C0	75.032
256	3CC.CC0	107.981
257	3CC.0C0	137.884
258	3CC.0C0	164.743
259	3CC.CC0	188.557
260	3CC.0C0	209.327
261	3CC.0C0	227.051
262	3CC.CC0	241.730
263	3CC.CC0	253.365
264	3CC.CC0	261.955
265	3CC.0C0	267.499
266	3CC.0C0	270.000
267	325.0CC	0.0
268	325.CCC	40.577
269	325.0CC	77.981
270	325.0C0	112.211
271	325.0C0	143.269
272	325.0C0	171.154
273	325.CC0	195.865
274	325.CCC	217.404
275	325.0C0	235.769
276	325.0CC	250.961
277	325.0C0	262.980
278	325.CCC	271.826
279	325.CCC	277.499
280	325.0C0	280.000
281	35C.0C0	0.0
282	35C.0C0	42.115
283	35C.CCC	80.929
284	35C.CCC	116.442
285	35C.0C0	148.654
286	35C.CC0	177.564
287	35C.0C0	203.173
288	35C.CC0	225.480
289	35C.0C0	244.487
290	35C.0C0	260.192
291	35C.0C0	272.595
292	35C.CC0	281.698
293	35C.CC0	287.499
294	35C.0C0	290.000
295	375.CCC	0.0
296	375.CC0	43.654
297	375.0CC	83.878
298	375.0CC	120.673
299	375.0C0	154.038
300	375.CC0	183.974
301	375.0C0	210.481
302	375.CC0	233.557
303	375.CCC	253.205
304	375.0C0	269.423
305	375.CC0	282.211
306	375.0C0	291.570
307	375.0CC	297.499
308	375.0C0	300.000
309	4CC.0C0	0.0
310	4CC.0C0	43.654
311	4CC.0C0	83.878
312	4CC.CC0	120.673
313	4CC.0C0	154.038
314	4CC.0C0	183.974
315	4CC.0C0	210.481
316	4CC.0C0	233.557
317	4CC.0C0	253.205
318	4CC.CC0	269.423
319	4CC.0C0	282.211
320	4CC.0C0	291.570
321	4CC.0C0	297.499

322	400.000	300.000
323	425.000	0.0
324	425.000	43.654
325	425.000	83.878
326	425.000	120.673
327	425.000	154.038
328	425.000	183.974
329	425.000	210.481
330	425.000	233.557
331	425.000	253.205
332	425.000	269.423
333	425.000	282.211
334	425.000	291.570
335	425.000	297.499
336	425.000	300.000
337	450.000	0.0
338	450.000	43.654
339	450.000	83.878
340	450.000	120.673
341	450.000	154.038
342	450.000	183.974
343	450.000	210.481
344	450.000	233.557
345	450.000	253.205
346	450.000	269.423
347	450.000	282.211
348	450.000	291.570
349	450.000	297.499
350	450.000	300.000
351	475.000	0.0
352	475.000	43.654
353	475.000	83.878
354	475.000	120.673
355	475.000	154.038
356	475.000	183.974
357	475.000	210.481
358	475.000	233.557
359	475.000	253.205
360	475.000	269.423
361	475.000	282.211
362	475.000	291.570
363	475.000	297.499
364	475.000	300.000
365	500.000	0.0
366	500.000	43.654
367	500.000	83.878
368	500.000	120.673
369	500.000	154.038
370	500.000	183.974
371	500.000	210.481
372	500.000	233.557
373	500.000	253.205
374	500.000	269.423
375	500.000	282.211
376	500.000	291.570
377	500.000	297.499
378	500.000	300.000
379	525.000	0.0
380	525.000	43.654
381	525.000	83.878
382	525.000	120.673
383	525.000	154.038
384	525.000	183.974
385	525.000	210.481
386	525.000	233.557
387	525.000	253.205
388	525.000	269.423
389	525.000	282.211
390	525.000	291.570
391	525.000	297.499
392	525.000	300.000
393	550.000	0.0
394	550.000	43.654
395	550.000	83.878
396	550.000	120.673
397	550.000	154.038
398	550.000	183.974
399	550.000	210.481
400	550.000	233.557
401	550.000	253.205

```
   402   550.000   269.423
   403   550.000   282.211
   404   550.000   291.570
   405   550.000   297.499
   406   550.000   300.000
   407   575.000     0.0
   408   575.000    43.654
   409   575.000    83.878
   410   575.000   120.673
   411   575.000   154.038
   412   575.000   183.974
   413   575.000   210.481
   414   575.000   233.557
   415   575.000   253.205
   416   575.000   269.423
   417   575.000   282.211
   418   575.000   291.570
   419   575.000   297.499
   420   575.000   300.000
   421   600.000     0.0
   422   600.000    43.654
   423   600.000    83.878
   424   600.000   120.673
   425   600.000   154.038
   426   600.000   183.974
   427   600.000   210.481
   428   600.000   233.557
   429   600.000   253.205
   430   600.000   269.423
   431   600.000   282.211
   432   600.000   291.570
   433   600.000   297.499
   434   600.000   300.000


CF.        ...  9.  ELEMENT DEFINITIONS.  FORMAT (16I5)  ...

    1    1   15   16    2    1   13   30


CF.        ...  11.  CARD INPUT FOR INITIAL OR PREINITIAL
                     CONDITIONS.  FORMAT (I5,5X,F10.0)      ...

    1     0.
  434     0.


CF.        ...  12.  STEADY-STATE INTEGER PARAMETERS.  FORMAT (16I5)  ...

   22    0    0    0    0    0


CF.        ...  16.  STEADY-STATE DIRICHLET PRESSURE-TYPE
                     BOUNDARY CONDITIONS.  FORMAT (2I5,2F10.0)  ...

   14    0 5.
   70   14 5.
   84     0.
   98     -3.83
  112    -10.49
  126    -17.94
  140    -25.82
  154    -33.99
  168    -42.39
  182    -50.95
  322    0 -100.
  434   14 -100.
```

```
CF.       ... 18.  TRANSIENT-STATE INTEGER PARAMETERS.  FCRMAT (16I5)  ...

    5    C    2    2   17   17


CF.       ... 19.  TRANSIENT-STATE RAINFALL PROFILES.  FCRMAT (8F10.0)  ...

C.         16620.
.005       .CC5
0.         16620.
0.         C.


CF.       ... 20.  TRANSIENT-STATE RAINFALL TYPES AND
                   PONDING DEPTHS.  FCRMAT (3I5.5X.2F10.0)  ...

   84    2    0     0.
  182    2   14     0.
  322    1    0     0.
  434    1   14     0.


CF.       ... 21.  TRANSIENT-STATE RAINFALL-SEEPAGE
                   SURFACE ELEMENTS.  FCRMAT (16I5)  ...

   65   7C   84    0
  169  182  196   13
  299  322  336    0
  390  420  434   13


CF.       ... 22.  TRANSIENT-STATE DIRICHLET PRESSURE-TYPE
                   BOUNDARY CONDITICNS.  FCRMAT (2I5.2F10.0)  ...

   14    C 5.
   70   14 5.
```

TO MINIMIZE CORE STORAGE REQUIREMENTS. SEVERAL STATEMENTS SHOULD BE EXCHANGED WITH THEIR COUNTERPARTS IN APPENDIX C. THE DIMENSION AND DATA STATEMENTS APPEAR ONLY IN PROGRAM MAIN. COMMON/GEOM/, HOWEVER, IS PRESENT IN A NUMBER OF ROUTINES --MAIN, DATAIN, VELT, BCPREP, BC, ASEMBL, SPROP, STORE, SURF, AND SFLOW. COMMON /RFSP/ IS USED BY ROUTINES MAIN, DATAIN, BCPREP, BC, STORE, AND SFLOW. THE PRESCRIPTION FOR ADAPTING THE COMMON AND DIMENSION STATEMENTS TO OTHER PROBLEMS IS PRESENTED IN THE OPENING COMMENT STATEMENTS OF PROGRAM MAIN (SEE APPENDIX C). DIMENSION, DATA, AND COMMON STATEMENTS APPROPRIATE FOR THE REEVES-DUGUID-CASE-2 FREEZE COMPARISON ARE AS FOLLOWS.

```
 DIMENSION R(434 ),RP(434 ),H(434 ),HP(434 ),HT(434 ),HW(434 ),
> BFLXP(434 ),BFLX(434 ),RSFLX(434 ),NPCNV(434 ),C(434 ,16),
> TH(390 ,4),DTH(390 ,4),AKX(390 ,4),AKZ(390 ,4),VX(390 ,4),
> VZ(390 ,4),AKPAR(3,2),KPR(2500),SUBHD(8,3),FRATE(10),FLOW(10),
> TFLOW(10),TITLE(9),THPAR(3,8),PMAT(3,5)
```

```
 DATA MAXNP,MAXEL,MAXMAT,MAXHBP,MXRFPR,MXRPAR,MAXNTI /434,390 ,2,
> 16,2,20,2500/
```

```
 COMMON/GEOM/X(434 ),Z(434 ),BB(434 ),DCOSXB(390 ),DCOSZB(390 ),
> DLB(390 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(434 ),NPST(434 ),
> NBE(390 ),IE(390 ,5),ISB(390 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
> NBEL,NSTN,NSTRT
```

```
 COMMON/RFSP/DCYFLX(434 ),HCON(434 ),FLX(434 ),DCOSX(390 ),
> DCOSZ(390 ),DL(390 ),TRF(2,20),RF(2,20),RFALL(2),IRFTYP(434 ),
> NPRS(434 ),NPCON(434 ),NFFLX(434 ),NRSE(390 ),IS(390 ,4),NRFPR,
> NRFPAR,NRSEL,NRSN
```

SUBROUTINE SPROP MUST OCCASIONALLY BE CHANGED TO ACCOMMODATE THE FORM OF THE INPUT SOIL PROPERTIES. THE SPROP OF APPENDIX C INTERPOLATES TABULAR DATA FOR ALL PROPERTIES EXCEPT THE HYDRAULIC CONDUCTIVITY, WHERE A GARDNER FORM IS USED. THE FOLLOWING VERSION OF SPROP INTERPOLATES ALL SOIL PROPERTIES, INCLUDING THE CONDUCTIVITY.

```
      SUBROUTINE SPROP(TH,DTH,AKX,AKZ,H,MAXEL,MAXNP)
C
C
C     FUNCTION OF SUBROUTINE--TO CALCULATE SOIL PROPERTIES, I.E. THE
C     WATER CONTENTS TH(M,IQ), WATER CAPACITIES DTH(M,IQ), AND
C     PRINCIPAL VALUES OF THE CONDUCTIVITY TENSOR AKX(M,IQ) AND AKZ(M,IQ).
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(434 ),Z(434 ),BB(434 ),DCOSXB(390 ),DCOSZB(390 ),
     > DLB(390 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(434 ),NPST(434 ),
     > NBE(390 ),IE(390 ,5),ISB(390 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/MTL/PROP(2,5),THPROP(2,52),AKPROP(2,52),HPROP(2,52),
     > CAPROP(2,52),NSPPM
      DIMENSION TH(MAXEL,4),AKX(MAXEL,4),AKZ(MAXEL,4),DTH(MAXEL,4),
     > H(MAXNP)
      DO 70 M=1,NEL
         MTYP=IE(M,5)
         DO 60 IQ=1,4
            NP=IE(M,IQ)
            HNP=H(NP)
            IF (HNP.GT.HPROP(MTYP,1)) GO TO 10
            JL=1
            JU=2
            A=0.
            GO TO 50
   10       IF (HNP.LT.HPROP(MTYP,NSPPM)) GO TO 20
            JL=NSPPM
            JU=1
            A=0.
            GO TO 50
   20       DO 30 J=2,NSPPM
               JU=J
               IF (HPROP(MTYP,J).GT.HNP) GO TO 40
   30          CONTINUE
   40       JL=JU-1
            A=(HNP-HPROP(MTYP,JL))/(HPROP(MTYP,JU)-HPROP(MTYP,JL))
   50       TH(M,IQ)=THPROP(MTYP,JL)+A*(THPROP(MTYP,JU)-THPROP(MTYP,JL))
            DTH(M,IQ)=CAPROP(MTYP,JL)+A*(CAPROP(MTYP,JU)-CAPROP(MTYP,JL)
     >      )
            AKX(M,IQ)=AKPROP(MTYP,JL)+A*(AKPROP(MTYP,JU)-AKPROP(MTYP,JL)
     >      )
C           AKS=AKPROP(MTYP,1)
C           HC=AKPROP(MTYP,2)
C           AN=AKPROP(MTYP,3)
C           IF(HNP.LT.0.D0) GO TO 55
C           AKX(M,IQ)=AKS
C           GO TO 60
C  55       AKX(M,IQ)=AKS/((HNP/HC)**AN+1.)
   60       AKZ(M,IQ)=AKX(M,IQ)




70    CONTINUE
      RETURN
      END
```

```
PROBLEM  773..  FREEZE TRANSIENT PROBLEM. MESH MODIFICATION

INPUT TABLE 1.. BASIC PARAMETERS

      NUMBER OF NODAL POINTS. . . . . . . . . . .  434
      NUMBER OF ELEMENTS. . . . . . . . . . . . .  390
      NUMBER OF DIFFERENT MATERIALS . . . . . .      1
      NUMBER OF CORRECTION MATERIALS. . . . . .      0
      NUMBER OF TIME INCREMENTS . . . . . . . .     70
      STEADY-STATE I.C. CONTROL . . . . . . . .      0
      SOIL-PROPERTY CONTROL . . . . . . . . . .      1
      NUMBER OF SOIL PARAMETERS . . . . . . . .     16
      AUXILIARY STORAGE CONTROL . . . . . . . .      0
      CONDUCTIVITY-PERMEABILITY CONTROL . . . .      1
      GRAVITY CONTROL . . . . . . . . . . . . .      0
      RESTART PARAMETER . . . . . . . . . . . .      0
      MAXIMUM ITERATIONS PER CYCLE. . . . . . .     25
      MAXIMUM CYCLES PER TIME STEP. . . . . . .      3
      TIME INCREMENT. . . . . . . . . . . . . .  0.100000
      MULTIPLIER FOR INCREASING DELT. . . . . .  0.500000
      MAXIMUM VALUE OF DELT . . . . . . . . . .0.20000 03
      MAXIMUM VALUE OF TIME . . . . . . . . . .0.10000 51
      DEGREES OF PRIN-AXIS INCLINATION. . . .    0.0
      STEADY-STATE TOLERANCE. . . . . . . . . .  0.010000
      TRANSIENT-STATE TOLERANCE . . . . . . . .  0.100000
      DENSITY OF WATER. . . . . . . . . . . . .  1.000000
      ACCELERATION OF GRAVITY . . . . . . . . .   980.600
      VISCOSITY OF WATER. . . . . . . . . . . .  0.013000
      TIME-INTEGRATION PARAMETER. . . . . . . .  0.500000

      OUTPUT CONTROL
         00000000000000000000000000000000000000000000000000000000000000000000000000000002
```

INPUT TABLE 2.. MATERIAL PROPERTIES

MAT. NO.	ALP	BETAP	POR	KX	KZ
1	0.0	0.0	0.30000 00	0.58000-07	0.58000-07

INPUT TABLE 3.. SOIL-PROPERTIES INTERPOLATION VALUES

MAT. NO.	PRESSURE	MOISTURE CONTENT	CONDUCTIVITY/PERMEABILITY	WATER CAPACITY
1	-0.8000D 03	0.2400D-01	0.4400D-08	0.0
	-0.4000D 03	0.3200D-01	0.5200D-08	0.5200D-04
	-0.2000D 03	0.4250D-01	0.6500D-08	0.1000D-03
	-0.1750D 03	0.4500D-01	0.7000D-08	0.2000D-03
	-0.1500D 03	0.5000D-01	0.8000D-08	0.5000D-03
	-0.1250D 03	0.6250D-01	0.9500D-08	0.1100D-02
	-0.1000D 03	0.9000D-01	0.1600D-07	0.3200D-02
	-0.6250D 02	0.2100D 00	0.4000D-07	0.3200D-02
	-0.5000D 02	0.2500D 00	0.4800D-07	0.2000D-02
	-0.3750D 02	0.2750D 00	0.5300D-07	0.8000D-03
	-0.2500D 02	0.2850D 00	0.5500D-07	0.4000D-03
	-0.1250D 02	0.2900D 00	0.5600D-07	0.2000D-03
	0.0	0.2925D 00	0.5600D-07	0.1000D-03
	0.5000D 02	0.2975D 00	0.5700D-07	0.4000D-04
	0.1000D 03	0.2995D 00	0.5800D-07	0.2600D-06
	0.2000D 04	0.3000D 00	0.5800D-07	0.0

INPUT TABLE 5.. NODAL POINT DATA

NODE	X	Z
1	0.0	0.0
2	0.0	0.1750D 02
3	0.0	0.3375D 02
4	0.0	0.4875D 02
5	0.0	0.6250D 02
6	0.0	0.7500D 02
7	0.0	0.8625D 02
8	0.0	0.9625D 02
9	0.0	0.1050D 03
10	0.0	0.1125D 03
11	0.0	0.1188D 03
12	0.0	0.1238D 03
13	0.0	0.1275D 03
14	0.0	0.1300D 03
15	0.2500D 02	0.0
16	0.2500D 02	0.1750D 02
17	0.2500D 02	0.3375D 02
18	0.2500D 02	0.4875D 02
19	0.2500D 02	0.6250D 02
20	0.2500D 02	0.7500D 02
21	0.2500D 02	0.8625D 02
22	0.2500D 02	0.9625D 02
23	0.2500D 02	0.1050D 03
24	0.2500D 02	0.1125D 03
25	0.2500D 02	0.1188D 03
26	0.2500D 02	0.1238D 03
27	0.2500D 02	0.1275D 03
28	0.2500D 02	0.1300D 03
29	0.5000D 02	0.0
30	0.5000D 02	0.1750D 02
31	0.5000D 02	0.3375D 02
32	0.5000D 02	0.4875D 02
33	0.5000D 02	0.6250D 02
34	0.5000D 02	0.7500D 02
35	0.5000D 02	0.8625D 02
36	0.5000D 02	0.9625D 02
37	0.5000D 02	0.1050D 03
38	0.5000D 02	0.1125D 03
39	0.5000D 02	0.1188D 03
40	0.5000D 02	0.1238D 03
41	0.5000D 02	0.1275D 03
42	0.5000D 02	0.1300D 03
43	0.7500D 02	0.0
44	0.7500D 02	0.1750D 02
45	0.7500D 02	0.3375D 02
46	0.7500D 02	0.4875D 02
47	0.7500D 02	0.6250D 02
48	0.7500D 02	0.7500D 02
49	0.7500D 02	0.8625D 02
50	0.7500D 02	0.9625D 02
51	0.7500D 02	0.1050D 03
52	0.7500D 02	0.1125D 03
53	0.7500D 02	0.1188D 03
54	0.7500D 02	0.1238D 03
55	0.7500D 02	0.1275D 03
56	0.7500D 02	0.1300D 03
57	0.1000D 03	0.0
58	0.1000D 03	0.1750D 02
59	0.1000D 03	0.3375D 02
60	0.1000D 03	0.4875D 02
61	0.1000D 03	0.6250D 02
62	0.1000D 03	0.7500D 02
63	0.1000D 03	0.8625D 02
64	0.1000D 03	0.9625D 02
65	0.1000D 03	0.1050D 03
66	0.1000D 03	0.1125D 03
67	0.1000D 03	0.1188D 03
68	0.1000D 03	0.1238D 03
69	0.1000D 03	0.1275D 03
70	0.1000D 03	0.1300D 03
71	0.1100D 03	0.0
72	0.1100D 03	0.1904D 02
73	0.1100D 03	0.3670D 02
74	0.1100D 03	0.5298D 02
75	0.1100D 03	0.6785D 02
76	0.1100D 03	0.8141D 02
77	0.1100D 03	0.9356D 02

78	0.11CCD 03	C.1C43D 03
79	0.1100D 03	C.1137D 03
80	0.11CCD 03	C.1217D 03
81	C.11CCD 03	C.1284D 03
82	0.11CCD C3	C.1336D 03
83	0.11CCD 03	C.1375D 03
84	0.11CCD 03	C.140CD 03
85	0.12CCD 03	C.C
86	C.12CCD 03	C.2C58D 02
87	C.12CCD 03	C.3965D 02
88	0.12CCD 03	C.5721D 02
89	0.1200D 03	C.7327D 02
90	0.12CCD 03	0.8782D 02
91	0.12CCD 03	C.1C09D 03
92	C.12CCD 03	C.1124D 03
93	0.12CCD 03	C.1224D 03
94	0.1200D 03	C.131CD 03
95	0.12CCD 03	C.1380D 03
96	0.12CCD 03	C.1435D 03
97	0.12CCD 03	C.1475D 03
98	0.12CCD 03	C.150CD 03
99	0.13CCD 03	C.C
100	0.13CCD 03	C.2212D 02
101	0.13CCD 03	C.4260D 02
102	0.13CCD 03	C.6144D 02
103	C.13CCD 03	C.7865D 02
104	0.130CD 03	C.9423D 02
105	C.130CD 03	C.1C82D 03
106	0.13CCD 03	C.1205D 03
107	0.13CCD 03	C.1312D 03
108	0.130CD 03	C.1402D 03
109	0.13CCD 03	C.1476D 03
110	0.13CCD 03	C.1534D 03
111	0.13CCD 03	C.1575D 03
112	0.13CCD 03	C.160CD 03
113	0.14CCD 03	C.C
114	0.14CCD 03	C.2365D 02
115	0.14CCD 03	C.4555D 02
116	0.14CCD 03	C.6567D 02
117	0.14CCD 03	C.8404D 02
118	0.14CCD 03	C.1CC6D 03
119	0.140CD 03	C.1155D 03
120	0.14CCD 03	C.1286D 03
121	0.14CCD 03	C.1399D 03
122	0.14CCD 03	C.1494D 03
123	0.14CCD 03	C.1572D 03
124	0.14CCD 03	C.1632D 03
125	0.14CCD 03	C.1675D 03
126	0.1400D 03	C.170CD 03
127	0.150CD 03	C.C
128	0.15CCD 03	C.2519D 02
129	0.15CCD 03	C.4849D 02
130	0.15CCD 03	C.659CD 02
131	0.1500D 03	C.8542D 02
132	0.15CCD 03	C.1C71D 03
133	0.15CCD 03	C.1228D 03
134	0.15CCD 03	C.1366D 03
135	0.15CCD 03	C.1486D 03
136	0.1500D 03	C.1587D 03
137	0.150CD 03	C.1668D 03
138	0.15CCD 03	C.1731D 03
139	0.15CCD C3	C.1775D 03
140	0.150CD 03	C.180CD 03
141	0.160CD 03	C.0
142	0.16CCD 03	C.2673D 02
143	C.16CCD 03	C.5144D 02
144	0.16CCD 03	C.7414D 02
145	0.16CCD 03	C.9481D 02
146	0.16CCD 03	C.1135D 03
147	0.16CCD 03	C.1301D 03
148	0.16CCD 03	C.1447D 03
149	C.16CCD 03	C.1573D 03
150	0.16CCD 03	C.1679D 03
151	0.16CCD 03	C.1764D 03
152	0.160CD 03	C.1830D 03
153	0.16CCD 03	C.1875D 03
154	0.16CCD 03	C.1900D 03
155	0.17CCD 03	C.0
156	0.170CD 03	C.2827D 02
157	0.170CD 03	C.5439D 02

158	0.17CCD 03	C.7837D 02
159	0.17CCD 03	C.1C02D 03
160	0.17CCD 03	C.1199D 03
161	0.17CCD 03	C.1374D 03
162	0.17CCD 03	C.1528D 03
163	0.17CCD 03	C.166CD 03
164	0.17CCD 03	C.1771D 03
165	0.17CCD 03	C.1861D 03
166	0.17CCD 03	C.1929D 03
167	0.170CD 03	C.1975D 03
168	0.17CCD 03	C.2000D 03
169	0.180CD 03	C.C
170	0.180CD 03	C.2981D 02
171	0.18C0D 03	C.5734D 02
172	0.18CCD 03	C.826CD 02
173	0.18CCD 03	C.1C56D 03
174	0.18CCD 03	C.1263D 03
175	0.18CCD 03	C.1447D 03
176	0.180CD 03	C.1609D 03
177	0.18CCD 03	C.1747D 03
178	0.18CCD 03	C.1863D 03
179	0.18CCD 03	C.1957D 03
180	0.18CCD 03	C.2C27D 03
181	0.18CCD 03	C.2C75D 03
182	0.18CCD 03	C.210CD 03
183	0.190CD 03	C.C
184	0.19CCD 03	C.3135D 02
185	0.19CCD 03	C.6C29D 02
186	0.190CD 03	C.8683D 02
187	0.1900D 03	C.111CD 03
188	0.19CCD 03	C.1327D 03
189	0.19CCD 03	C.1520D 03
190	0.1900D 03	C.1689D 03
191	C.19CCD 03	C.1835D 03
192	0.19CCD 03	C.1956D 03
195	0.19CCD 03	C.2175D 03
196	0.19CCD 03	C.220CD 03
197	0.200CD 03	C.C
198	0.20CCD 03	C.3289D 02
199	0.20CCD 03	C.6324D 02
200	C.20CCD 03	C.9106D 02
201	C.20CCD 03	C.1163D 03
202	C.20CCD 03	C.1391D 03
203	C.20CCD 03	C.1593D 03
204	0.20CCD 03	C.177CD 03
205	0.200CD 03	C.1922D 03
206	C.200CD 03	C.2C48D 03
207	0.20CCD 03	C.2149D 03
208	C.20CCD 03	C.2225D 03
209	0.20CCD 03	C.2275D 03
210	0.2000D 03	C.230CD 03
211	0.225CD 03	C.C
212	0.225CD 03	C.3442D 02
213	C.225CD 03	C.6619D 02
214	0.225CD 03	C.9529D 02
215	0.2250D 03	C.1217D 03
216	0.2250D 03	C.1455D 03
217	0.225CD 03	C.1666D 03
218	0.225CD 03	C.1851D 03
219	0.225CD 03	C.2C09D 03
220	0.2250D 03	C.214CD 03
221	0.2250D 03	C.2245D 03
222	C.225CD 03	C.2323D 03
223	C.225CD 03	C.2375D 03
224	0.225CD 03	C.240CD 03
225	0.2500D 03	C.C
226	0.2500D 03	C.3596D 02
227	0.25CCD 03	C.6914D 02
228	0.25CCD 03	C.9952D 02
229	0.25CCD 03	C.1271D 03
230	0.2500D 03	C.1519D 03
231	0.25CCD 03	C.1739D 03
232	0.250CD 03	C.1932D 03
233	C.25CCD 03	C.2C96D 03
234	0.25CCD 03	C.2233D 03
235	0.2500D 03	C.2341D 03
236	C.25CCD 03	C.2422D 03
237	C.25CCD 03	C.2475D 03
238	C.25CCD 03	C.250CD 03
239	0.275CD 03	C.0

240	0.2750D 03	0.3750D 02
241	0.2750D 03	0.7208D 02
242	0.2750D 03	0.1038D 03
243	0.2750D 03	0.1325D 03
244	0.2750D 03	0.1583D 03
245	0.2750D 03	0.1813D 03
246	0.2750D 03	0.2013D 03
247	0.2750D 03	0.2183D 03
248	0.2750D 03	0.2325D 03
249	0.2750D 03	0.2438D 03
250	0.2750D 03	0.2521D 03
251	0.2750D 03	0.2575D 03
252	0.2750D 03	0.2600D 03
253	0.3000D 03	0.0
254	0.3000D 03	0.3904D 02
255	0.3000D 03	0.7503D 02
256	0.3000D 03	0.1080D 03
257	0.3000D 03	0.1379D 03
258	0.3000D 03	0.1647D 03
259	0.3000D 03	0.1886D 03
260	0.3000D 03	0.2093D 03
261	0.3000D 03	0.2271D 03
262	0.3000D 03	0.2417D 03
263	0.3000D 03	0.2534D 03
264	0.3000D 03	0.2620D 03
265	0.3000D 03	0.2675D 03
266	0.3000D 03	0.2700D 03
267	0.3250D 03	0.0
268	0.3250D 03	0.4058D 02
269	0.3250D 03	0.7798D 02
270	0.3250D 03	0.1122D 03
271	0.3250D 03	0.1433D 03
272	0.3250D 03	0.1712D 03
273	0.3250D 03	0.1959D 03
274	0.3250D 03	0.2174D 03
275	0.3250D 03	0.2358D 03
276	0.3250D 03	0.2510D 03
277	0.3250D 03	0.2630D 03
278	0.3250D 03	0.2718D 03
279	0.3250D 03	0.2775D 03
280	0.3250D 03	0.2800D 03
281	0.3500D 03	0.0
282	0.3500D 03	0.4212D 02
283	0.3500D 03	0.8093D 02
284	0.3500D 03	0.1164D 03
285	0.3500D 03	0.1487D 03
286	0.3500D 03	0.1776D 03
287	0.3500D 03	0.2032D 03
288	0.3500D 03	0.2255D 03
289	0.3500D 03	0.2445D 03
290	0.3500D 03	0.2602D 03
291	0.3500D 03	0.2726D 03
292	0.3500D 03	0.2817D 03
293	0.3500D 03	0.2875D 03
294	0.3500D 03	0.2900D 03
295	0.3750D 03	0.0
296	0.3750D 03	0.4365D 02
297	0.3750D 03	0.8388D 02
298	0.3750D 03	0.1207D 03
299	0.3750D 03	0.1540D 03
300	0.3750D 03	0.1840D 03
301	0.3750D 03	0.2105D 03
302	0.3750D 03	0.2336D 03
303	0.3750D 03	0.2532D 03
304	0.3750D 03	0.2694D 03
305	0.3750D 03	0.2822D 03
306	0.3750D 03	0.2916D 03
307	0.3750D 03	0.2975D 03
308	0.3750D 03	0.3000D 03
309	0.4000D 03	0.0
310	0.4000D 03	0.4365D 02
311	0.4000D 03	0.8388D 02
312	0.4000D 03	0.1207D 03
313	0.4000D 03	0.1540D 03
314	0.4000D 03	0.1840D 03
315	0.4000D 03	0.2105D 03
316	0.4000D 03	0.2336D 03
317	0.4000D 03	0.2532D 03
318	0.4000D 03	0.2694D 03
319	0.4000D 03	0.2822D 03

320	0.40CCD 03	C.2916D 03
321	0.40C0D 03	C.2975D 03
322	0.40CCD 03	C.300CD 03
323	0.425CD 03	C.C
324	C.425CD 03	C.4365D 02
325	0.425CD 03	C.8388D 02
326	C.425CD 03	C.1207D 03
327	C.425CD C3	C.1540D 03
328	0.425CD C3	C.184CD 03
329	0.425CD C3	C.2105D 03
330	C.425CD 03	C.2336D 03
331	0.425CD C3	C.2532D 03
332	0.425CD C3	C.2694D 03
333	0.425CD C3	C.2822D 03
334	0.4250D 03	C.2916D 03
335	0.425C0 03	C.2975D 03
336	C.425CD C3	C.3C00D 03
337	C.45CCD 03	C.0
338	0.45CCD C3	C.4365D 02
339	0.45CCD 03	C.8388D 02
340	C.45CCD 03	C.1207D 03
341	C.45CCD 03	C.154CD 03
342	0.45CCD 03	C.184CD 03
343	0.45CCD 03	C.2105D 03
344	0.4500D 03	C.2336D 03
345	0.45CCD 03	C.2532D 03
346	C.45CCD 03	C.2694D 03
347	0.45CCD 03	C.2822D 03
348	0.45CCD 03	C.2916D 03
349	0.4500D 03	C.2975D 03
350	C.45CCD 03	C.300CD 03
351	C.475CD C3	C.C
352	C.475CD 03	C.4365D 02
353	0.475CD C3	C.8388D 02
354	0.4750D 03	C.1207D 03
355	0.475CD 03	C.1540D 03
356	0.475CD C3	C.184CD 03
357	C.475CD C3	C.2105D 03
358	C.475CD C3	C.2336D 03
359	0.475CD 03	C.2532D 03
360	0.475CD 03	C.2694D 03
361	0.475CD 03	C.2822D 03
362	0.475CD C3	C.2916D 03
363	0.475CD C3	C.2975D 03
364	0.475CD 03	C.3C0CD 03
365	0.50CCD 03	C.0
366	C.50CCD 03	C.4365D 02
367	C.50CCD 03	C.8388D 02
368	0.50CCD 03	C.1207D 03
369	0.50CCD 03	C.154CD 03
370	0.50CCD 03	C.1840D 03
371	0.50CCD 03	C.2105D 03
372	0.50CCD 03	C.2336D 03
373	0.50CCD 03	C.2532D 03
374	0.50CCD 03	C.2694D 03
375	C.50CCD 03	C.2822D 03
376	0.50CCD 03	C.2916D 03
377	0.50CCD 03	C.2975D 03
378	0.500CD 03	C.3C0CD 03
379	C.525CD 03	C.C
380	C.525CD 03	C.4365D 02
381	0.525CD 03	C.8388D 02
382	0.525CD 03	C.1207D 03
383	0.525CD 03	C.154CD 03
384	0.525CD 03	C.184CD 03
385	C.525CD 03	C.2105D 03
386	C.525CD 03	C.2336D 03
387	0.525CD 03	C.2532D 03
388	C.525CD 03	C.2694D 03
389	0.525CD 03	C.2822D 03
390	0.525CD C3	C.2916D 03
391	0.525CD 03	C.2975D 03
392	0.525CD C3	C.300CD 03
393	0.55CCD 03	C.C
394	0.55CCD 03	C.4365D 02
395	0.55CCD 03	C.8388D 02
396	C.55CCD 03	C.1207D 03
397	0.55CCD 03	C.154CD 03
398	C.55CCD 03	C.184CD 03
399	0.550CD 03	C.2105D 03

400	0.550CD 03	C.2336D 03
401	0.55CCD 03	C.2532D 03
402	0.55CCD 03	C.2694D 03
403	0.55CCD 03	C.2822D 03
404	0.55CCD 03	C.2916D 03
405	0.550CD 03	C.2975D 03
406	0.55C0D 03	C.3COCD 03
407	0.575CD C3	C.C
408	0.575CD 03	C.4365D 02
409	0.575CD 03	C.8388D 02
410	0.5750D 03	C.1207D 03
411	0.575CD 03	C.1540D 03
412	0.575CD 03	C.184CD 03
413	0.575CD C3	C.2105D 03
414	0.575CD 03	C.2336D 03
415	0.5750D 03	C.2532D 03
416	0.575CD 03	C.2694D 03
417	0.575CD 03	C.2822D 03
418	0.575CD 03	C.2916D 03
419	0.575CD 03	C.2975D 03
420	0.5750D 03	C.3COCD 03
421	0.60CCD 03	C.C
422	C.60CCD 03	C.4365D 02
423	C.60CCD 03	C.8388D 02
424	0.60CCD 03	C.1207D 03
425	0.60CCD 03	C.154CD 03
426	0.60CCD 03	C.1840D 03
427	C.60CCD 03	C.2105D 03
428	0.60CCD 03	C.2336D 03
429	0.60CCD 03	C.2532D 03
430	0.600CD 03	C.2694D 03
431	0.60CCD 03	C.2822D 03
432	C.60CCD 03	C.2916D 03
433	0.60CCD 03	C.2975D 03
434	0.60CCD 03	C.3COCD 03

INPUT TABLE 6.. ELEMENT DATA

	GLOBAL INDICES OF ELEMENT NODES					
ELEMENT	1	2	3	4	MATERIAL	NODE DIFF
1	1	15	16	2	1	15
2	2	16	17	3	1	15
3	3	17	18	4	1	15
4	4	18	19	5	1	15
5	5	19	20	6	1	15
6	6	20	21	7	1	15
7	7	21	22	8	1	15
8	8	22	23	9	1	15
9	9	23	24	10	1	15
10	10	24	25	11	1	15
11	11	25	26	12	1	15
12	12	26	27	13	1	15
13	13	27	28	14	1	15
14	15	29	30	16	1	15
15	16	30	31	17	1	15
16	17	31	32	18	1	15
17	18	32	33	19	1	15
18	19	33	34	20	1	15
19	20	34	35	21	1	15
20	21	35	36	22	1	15
21	22	36	37	23	1	15
22	23	37	38	24	1	15
23	24	38	39	25	1	15
24	25	39	40	26	1	15
25	26	40	41	27	1	15
26	27	41	42	28	1	15
27	29	43	44	30	1	15
28	30	44	45	31	1	15
29	31	45	46	32	1	15
30	32	46	47	33	1	15
31	33	47	48	34	1	15
32	34	48	49	35	1	15
33	35	49	50	36	1	15
34	36	50	51	37	1	15
35	37	51	52	38	1	15
36	38	52	53	39	1	15
37	39	53	54	40	1	15
38	40	54	55	41	1	15
39	41	55	56	42	1	15
40	43	57	58	44	1	15
41	44	58	59	45	1	15
42	45	59	60	46	1	15
43	46	60	61	47	1	15
44	47	61	62	48	1	15
45	48	62	63	49	1	15
46	49	63	64	50	1	15
47	50	64	65	51	1	15
48	51	65	66	52	1	15
49	52	66	67	53	1	15
50	53	67	68	54	1	15
51	54	68	69	55	1	15
52	55	69	70	56	1	15
53	57	71	72	58	1	15
54	58	72	73	59	1	15
55	59	73	74	60	1	15
56	60	74	75	61	1	15
57	61	75	76	62	1	15
58	62	76	77	63	1	15
59	63	77	78	64	1	15
60	64	78	79	65	1	15
61	65	79	80	66	1	15
62	66	80	81	67	1	15
63	67	81	82	68	1	15
64	68	82	83	69	1	15
65	69	83	84	70	1	15
66	71	85	86	72	1	15
67	72	86	87	73	1	15
68	73	87	88	74	1	15
69	74	88	89	75	1	15
70	75	89	90	76	1	15
71	76	90	91	77	1	15
72	77	91	92	78	1	15
73	78	92	93	79	1	15
74	79	93	94	80	1	15
75	80	94	95	81	1	15
76	81	95	96	82	1	15
77	82	96	97	83	1	15

78	83	97	98	84	1	15
79	85	99	100	86	1	15
80	86	100	101	87	1	15
81	87	101	102	88	1	15
82	88	102	103	89	1	15
83	89	103	104	90	1	15
84	90	104	105	91	1	15
85	91	105	106	92	1	15
86	92	106	107	93	1	15
87	93	107	108	94	1	15
88	94	108	109	95	1	15
89	95	109	110	96	1	15
90	96	110	111	97	1	15
91	97	111	112	98	1	15
92	99	113	114	100	1	15
93	100	114	115	101	1	15
94	101	115	116	102	1	15
95	102	116	117	103	1	15
96	103	117	118	104	1	15
97	104	118	119	105	1	15
98	105	119	120	106	1	15
99	106	120	121	107	1	15
100	107	121	122	108	1	15
101	108	122	123	109	1	15
102	109	123	124	110	1	15
103	110	124	125	111	1	15
104	111	125	126	112	1	15
105	113	127	128	114	1	15
106	114	128	129	115	1	15
107	115	129	130	116	1	15
108	116	130	131	117	1	15
109	117	131	132	118	1	15
110	118	132	133	119	1	15
111	119	133	134	120	1	15
112	120	134	135	121	1	15
113	121	135	136	122	1	15
114	122	136	137	123	1	15
115	123	137	138	124	1	15
116	124	138	139	125	1	15
117	125	139	140	126	1	15
118	127	141	142	128	1	15
119	128	142	143	129	1	15
120	129	143	144	130	1	15
121	130	144	145	131	1	15
122	131	145	146	132	1	15
123	132	146	147	133	1	15
124	133	147	148	134	1	15
125	134	148	149	135	1	15
126	135	149	150	136	1	15
127	136	150	151	137	1	15
128	137	151	152	138	1	15
129	138	152	153	139	1	15
130	139	153	154	140	1	15
131	141	155	156	142	1	15
132	142	156	157	143	1	15
133	143	157	158	144	1	15
134	144	158	159	145	1	15
135	145	159	160	146	1	15
136	146	160	161	147	1	15
137	147	161	162	148	1	15
138	148	162	163	149	1	15
139	149	163	164	150	1	15
140	150	164	165	151	1	15
141	151	165	166	152	1	15
142	152	166	167	153	1	15
143	153	167	168	154	1	15
144	155	169	170	156	1	15
145	156	170	171	157	1	15
146	157	171	172	158	1	15
147	158	172	173	159	1	15
148	159	173	174	160	1	15
149	160	174	175	161	1	15
150	161	175	176	162	1	15
151	162	176	177	163	1	15
152	163	177	178	164	1	15
153	164	178	179	165	1	15
154	165	179	180	166	1	15
155	166	180	181	167	1	15
156	167	181	182	168	1	15
157	169	183	184	170	1	15
158	170	184	185	171	1	15

159	171	185	186	172	1	15
160	172	186	187	173	1	15
161	173	187	188	174	1	15
162	174	188	189	175	1	15
163	175	189	190	176	1	15
164	176	190	191	177	1	15
165	177	191	192	178	1	15
166	178	192	193	179	1	15
167	179	193	194	180	1	15
168	180	194	195	181	1	15
169	181	195	196	182	1	15
170	183	197	198	184	1	15
171	184	198	199	185	1	15
172	185	199	200	186	1	15
173	186	200	201	187	1	15
174	187	201	202	188	1	15
175	188	202	203	189	1	15
176	189	203	204	190	1	15
177	190	204	205	191	1	15
178	191	205	206	192	1	15
179	192	206	207	193	1	15
180	193	207	208	194	1	15
181	194	208	209	195	1	15
182	195	209	210	196	1	15
183	197	211	212	198	1	15
184	198	212	213	199	1	15
185	199	213	214	200	1	15
186	200	214	215	201	1	15
187	201	215	216	202	1	15
188	202	216	217	203	1	15
189	203	217	218	204	1	15
190	204	218	219	205	1	15
191	205	219	220	206	1	15
192	206	220	221	207	1	15
193	207	221	222	208	1	15
194	208	222	223	209	1	15
195	209	223	224	210	1	15
196	211	225	226	212	1	15
197	212	226	227	213	1	15
198	213	227	228	214	1	15
199	214	228	229	215	1	15
200	215	229	230	216	1	15
201	216	230	231	217	1	15
202	217	231	232	218	1	15
203	218	232	233	219	1	15
204	219	233	234	220	1	15
205	220	234	235	221	1	15
206	221	235	236	222	1	15
207	222	236	237	223	1	15
208	223	237	238	224	1	15
209	225	239	240	226	1	15
210	226	240	241	227	1	15
211	227	241	242	228	1	15
212	228	242	243	229	1	15
213	229	243	244	230	1	15
214	230	244	245	231	1	15
215	231	245	246	232	1	15
216	232	246	247	233	1	15
217	233	247	248	234	1	15
218	234	248	249	235	1	15
219	235	249	250	236	1	15
220	236	250	251	237	1	15
221	237	251	252	238	1	15
222	239	253	254	240	1	15
223	240	254	255	241	1	15
224	241	255	256	242	1	15
225	242	256	257	243	1	15
226	243	257	258	244	1	15
227	244	258	259	245	1	15
228	245	259	260	246	1	15
229	246	260	261	247	1	15
230	247	261	262	248	1	15
231	248	262	263	249	1	15
232	249	263	264	250	1	15
233	250	264	265	251	1	15
234	251	265	266	252	1	15
235	253	267	268	254	1	15
236	254	268	269	255	1	15
237	255	269	270	256	1	15
238	256	270	271	257	1	15

239	257	271	272	258	1	15
240	258	272	273	259	1	15
241	259	273	274	260	1	15
242	260	274	275	261	1	15
243	261	275	276	262	1	15
244	262	276	277	263	1	15
245	263	277	278	264	1	15
246	264	278	279	265	1	15
247	265	279	280	266	1	15
248	267	281	282	268	1	15
249	268	282	283	269	1	15
250	269	283	284	270	1	15
251	270	284	285	271	1	15
252	271	285	286	272	1	15
253	272	286	287	273	1	15
254	273	287	288	274	1	15
255	274	288	289	275	1	15
256	275	289	290	276	1	15
257	276	290	291	277	1	15
258	277	291	292	278	1	15
259	278	292	293	279	1	15
260	279	293	294	280	1	15
261	281	295	296	282	1	15
262	282	296	297	283	1	15
263	283	297	298	284	1	15
264	284	298	299	285	1	15
265	285	299	300	286	1	15
266	286	300	301	287	1	15
267	287	301	302	288	1	15
268	288	302	303	289	1	15
269	289	303	304	290	1	15
270	290	304	305	291	1	15
271	291	305	306	292	1	15
272	292	306	307	293	1	15
273	293	307	308	294	1	15
274	295	309	310	296	1	15
275	296	310	311	297	1	15
276	297	311	312	298	1	15
277	298	312	313	299	1	15
278	299	313	314	300	1	15
279	300	314	315	301	1	15
280	301	315	316	302	1	15
281	302	316	317	303	1	15
282	303	317	318	304	1	15
283	304	318	319	305	1	15
284	305	319	320	306	1	15
285	306	320	321	307	1	15
286	307	321	322	308	1	15
287	309	323	324	310	1	15
288	310	324	325	311	1	15
289	311	325	326	312	1	15
290	312	326	327	313	1	15
291	313	327	328	314	1	15
292	314	328	329	315	1	15
293	315	329	330	316	1	15
294	316	330	331	317	1	15
295	317	331	332	318	1	15
296	318	332	333	319	1	15
297	319	333	334	320	1	15
298	320	334	335	321	1	15
299	321	335	336	322	1	15
300	323	337	338	324	1	15
301	324	338	339	325	1	15
302	325	339	340	326	1	15
303	326	340	341	327	1	15
304	327	341	342	328	1	15
305	328	342	343	329	1	15
306	329	343	344	330	1	15
307	330	344	345	331	1	15
308	331	345	346	332	1	15
309	332	346	347	333	1	15
310	333	347	348	334	1	15
311	334	348	349	335	1	15
312	335	349	350	336	1	15
313	337	351	352	338	1	15
314	338	352	353	339	1	15
315	339	353	354	340	1	15
316	340	354	355	341	1	15
317	341	355	356	342	1	15
318	342	356	357	343	1	15

319	343	357	358	344	1	15
320	344	358	359	345	1	15
321	345	359	360	346	1	15
322	346	360	361	347	1	15
323	347	361	362	348	1	15
324	348	362	363	349	1	15
325	349	363	364	350	1	15
326	351	365	366	352	1	15
327	352	366	367	353	1	15
328	353	367	368	354	1	15
329	354	368	369	355	1	15
330	355	369	370	356	1	15
331	356	370	371	357	1	15
332	357	371	372	358	1	15
333	358	372	373	359	1	15
334	359	373	374	360	1	15
335	360	374	375	361	1	15
336	361	375	376	362	1	15
337	362	376	377	363	1	15
338	363	377	378	364	1	15
339	365	379	380	366	1	15
340	366	380	381	367	1	15
341	367	381	382	368	1	15
342	368	382	383	369	1	15
343	369	383	384	370	1	15
344	370	384	385	371	1	15
345	371	385	386	372	1	15
346	372	386	387	373	1	15
347	373	387	388	374	1	15
348	374	388	389	375	1	15
349	375	389	390	376	1	15
350	376	390	391	377	1	15
351	377	391	392	378	1	15
352	379	393	394	380	1	15
353	380	394	395	381	1	15
354	381	395	396	382	1	15
355	382	396	397	383	1	15
356	383	397	398	384	1	15
357	384	398	399	385	1	15
358	385	399	400	386	1	15
359	386	400	401	387	1	15
360	387	401	402	388	1	15
361	388	402	403	389	1	15
362	389	403	404	390	1	15
363	390	404	405	391	1	15
364	391	405	406	392	1	15
365	393	407	408	394	1	15
366	394	408	409	395	1	15
367	395	409	410	396	1	15
368	396	410	411	397	1	15
369	397	411	412	398	1	15
370	398	412	413	399	1	15
371	399	413	414	400	1	15
372	400	414	415	401	1	15
373	401	415	416	402	1	15
374	402	416	417	403	1	15
375	403	417	418	404	1	15
376	404	418	419	405	1	15
377	405	419	420	406	1	15
378	407	421	422	408	1	15
379	408	422	423	409	1	15
380	409	423	424	410	1	15
381	410	424	425	411	1	15
382	411	425	426	412	1	15
383	412	426	427	413	1	15
384	413	427	428	414	1	15
385	414	428	429	415	1	15
386	415	429	430	416	1	15
387	416	430	431	417	1	15
388	417	431	432	418	1	15
389	418	432	433	419	1	15
390	419	433	434	420	1	15

INPUT TABLE 7.. STEADY-STATE B.C. PARAMETERS

NUMBER OF BOUNDARY CONDITIONS	22
NUMBER OF SURFACE TERMS	0
NUMBER OF RAINFALL PROFILES	0
NUMBER OF RAINFALL PARAMETERS	0
NUMBER OF RAINFALL-SEEPAGE ELEMENTS . .	0
NUMBER OF RAINFALL-SEEPAGE NODES. . . .	0

INPUT TABLE 8.. STEADY-STATE BOUNDARY CONDITIONS OF FORM H=BB

NODE	BB
14	0.5000D 01
28	0.5000D 01
42	0.5000D 01
56	0.5000D 01
70	0.5000D 01
84	0.0
98	-0.3830D 01
112	-0.1049D 02
126	-0.1754D 02
140	-0.2582D 02
154	-0.3359D 02
168	-0.4239D 02
182	-0.5095D 02
322	-0.1000D 03
336	-0.1000D 03
350	-0.1000D 03
364	-0.1000D 03
378	-0.1000D 03
392	-0.1000D 03
406	-0.1000D 03
420	-0.1000D 03
434	-0.1000D 03

****

DIAGNOSTIC TABLE 1.. AT TIME = 0.0 .(DELT = 1.0000D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.1849D 03	0.0	412
2	0.5848D 01	0.1337D 02	411
3	0.6024D 00	0.2407D 01	389
4	0.3369D-01	0.4707D 00	209
5	0.4599D-02	0.1233D-01	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.5853D-02	0.0	0.0
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.0	0.0	0.0
RAINFALL	0.0	0.0	0.0
NUMERICAL LOSSES.	0.4733D-02	0.0	0.0
NET FLOW.	0.1059D-01	0.0	0.0
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.0	0.0	0.3977D 05

INPUT TABLE 10.. TRANSIENT B.C. PARAMETERS

NUMBER OF BOUNDARY CONDITIONS	5
NUMBER OF SURFACE TERMS	0
NUMBER OF RAINFALL PROFILES	2
NUMBER OF RAINFALL PARAMETERS	2
NUMBER OF RAINFALL-SEEPAGE ELEMENTS . .	17
NUMBER OF RAINFALL-SEEPAGE NODES. . . .	17

INPUT TABLE 11.. RAINFALL DATA

PROFILE 1

TIME	RATE
0.0	5.00000-03
1.66200 04	5.00000-03

PROFILE 2

TIME	RATE
0.0	0.0
1.66200 04	0.0

INPUT TABLE 12.. RAINFALL DISTRIBUTION AND PONDING

NODE	TYPE	DEPTH
84	2	0.0
98	2	0.0
112	2	0.0
126	2	0.0
140	2	0.0
154	2	0.0
168	2	0.0
182	2	0.0
322	1	0.0
336	1	0.0
350	1	0.0
364	1	0.0
378	1	0.0
392	1	0.0
406	1	0.0
420	1	0.0
434	1	0.0

INPUT TABLE 13.. RAINFALL-SEEPAGE SURFACE INFORMATION

ELEMENT	NODE 1	NODE 2
65	70	84
78	84	98
91	98	112
104	112	126
117	126	140
130	140	154
143	154	168
156	168	182
169	182	196
299	322	336
312	336	350
325	350	364
338	364	378
351	378	392
364	392	406
377	406	420
390	420	434

INPUT TABLE 14.. BOUNDARY CONDITIONS OF FORM H=BB

NODE	BB
14	0.50000 01
28	0.50000 01
42	0.50000 01
56	0.50000 01
70	0.50000 01

****

DIAGNOSTIC TABLE 2.. AT TIME = 1.0000D-01 .(DELT = 1.0000D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	C.1000D 03	C.1000D 01	85
2	C.2906D C1	C.6353D-01	50
3	C.2571D CC	C.6000D-02	4
4	C.2350D-C1	C.5519D-03	0
5	C.9994D 02	C.5560D 00	85
6	0.5119D-C4	C.5130D-06	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315C-01	0.8315C-02	0.8315D-02
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2123D-01	0.2123C-02	0.2123D-02
RAINFALL.	-0.1188D 00	-0.1188C-01	-0.1188D-01
NUMERICAL LOSSES.	0.4740C-02	0.4740C-03	C.4740D-03
NET FLOW.	-0.9644C-02	-0.9644C-03	-0.9644D-03
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9040C 00	0.9040C-01	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1967D-01	0.1481D-02	-C.3566D-03	0.3046D-04	-0.3710D-04	-C.1396D-04	0.2772D-04	C.1906D-04
-0.1839D-01	-0.1742D-01	-0.1473D-01	-0.1356D-01	-0.1276C-01	-0.1221D-01	-0.1185D-01	-C.1164D-C1
-C.5786D-02							

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DIAGNOSTIC TABLE 3.. AT TIME = 2.5000D-01 .(DELT = 1.5000D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.2982D 00	0.2988D-02	8
2	0.1348D-03	0.1355D-05	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315D-01	0.1247D-01	0.2079D-01
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2114D-01	0.3177D-02	0.5300D-02
RAINFALL.	-0.1495D 00	-0.2012D-01	-0.3199D-01
NUMERICAL LOSSES.	0.4749D-02	0.7117D-03	0.1186D-02
NET FLOW.	-0.4041D-01	-0.3754D-02	-0.4719D-02
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9040D 00	0.1356D 00	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1966D-01	0.1431D-02	-0.4565D-03	0.4035D-05	-0.3331D-04	-0.3920D-05	0.2401D-04	0.2111D-04
-0.1993D-01	-0.2119D-01	-0.1857D-01	-0.1743D-01	-0.1665D-01	-0.1612D-01	-0.1576D-01	-0.1556D-01
-0.7746D-02							

DIAGNOSTIC TABLE 4.. AT TIME = 4.7500D-01 .(DELT = 2.2500D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.4248D 00	0.1192D-01	9
2	0.3602D-03	0.3636D-05	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315D-01	0.1871D-01	0.3949D-01
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2123D-01	0.4767D-02	0.1007D-01
RAINFALL	-0.1934D 00	-0.3857D-01	-0.7056D-01
NUMERICAL LOSSES.	0.4758D-02	0.1070D-02	0.2255D-02
NET FLOW.	-0.8426D-01	-0.1403D-01	-0.1875D-01
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9040D 00	0.2034D 00	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1966D-01	0.1479D-02	-0.3554D-03	0.4005D-04	-0.2603D-04	0.6003D-06	0.2172D-04	0.2310D-04
-0.2212D-01	-0.2662D-01	-0.2410D-01	-0.2301D-01	-0.2225D-01	-0.2174D-01	-0.2140D-01	-0.2120D-01
-0.1057D-01							

DIAGNOSTIC TABLE 5.. AT TIME = 8.1250D-01 .(DELT = 3.3750D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.5900D 00	0.4442D-01	9
2	0.9615D-03	0.9764D-05	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315D-01	0.2806D-01	0.6756D-01
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2118D-01	0.7157D-02	0.1722D-01
RAINFALL	-0.2554D 00	-0.7573D-01	-0.1463D 00
NUMERICAL LOSSES.	0.4763D-02	0.1607D-02	0.3862D-02
NET FLOW.	-0.1463D 00	-0.3890D-01	-0.5765D-01
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9041D 00	0.3051D 00	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1966D-01	0.1448D-02	-0.4091D-03	0.2963D-04	-0.2264D-04	0.4027D-05	0.2075D-04	0.2443D-04
-0.2516D-01	-0.3425D-01	-0.3188D-01	-0.3084D-01	-0.3013D-01	-0.2965D-01	-0.2933D-01	-0.2915D-01
-0.1454D-01							

DIAGNOSTIC TABLE 6.. AT TIME = 1.3188D 00 .(DELT = 5.0625D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.7903D 00	0.6353D-01	9
2	0.2509D-02	0.2568D-04	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315D-01	0.4209D-01	0.1096D 00
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2124D-01	0.1074D-01	0.2796D-01
RAINFALL.	-0.3389D 00	-0.1504D 00	-0.2967D 00
NUMERICAL LOSSES.	0.4756D-02	0.2410D-02	0.6272D-02
NET FLOW.	-0.2298D 00	-0.9519D-01	-0.1528D 00
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9041D 00	0.4577D 00	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1966D-01	0.1481D-02	-0.3474D-03	0.4909D-04	-0.1942D-04	0.6618D-05	0.2005D-04	0.2513D-04
-0.2920D-01	-0.4456D-01	-0.4238D-01	-0.4143D-01	-0.4079D-01	-0.4035D-01	-0.4005D-01	-0.3988D-01
-0.1991D-01							

DIAGNOSTIC TABLE 7.. AT TIME = 2.0781D 00 .(DELT = 7.5937D-01)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.1005D 01	0.9508D-01	9
2	0.6232D-02	0.6445D-04	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315D-01	0.6314D-01	0.1728D 00
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2119D-01	0.1611D-01	0.4407D-01
RAINFALL.	-0.4445D 00	-0.2976D 00	-0.5943D 00
NUMERICAL LOSSES.	0.4727D-02	0.3601D-02	0.9872D-02
NET FLOW.	-0.3358D 00	-0.2148D 00	-0.3676D 00
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9041D 00	0.6866D 00	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1964D-01	0.1454D-02	-0.3892D-03	0.4144D-04	-0.1754D-04	0.8327D-05	0.1940D-04	0.2559D-04
-0.3425D-01	-0.5762D-01	-0.5570D-01	-0.5485D-01	-0.5429D-01	-0.5390D-01	-0.5365D-01	-0.5350D-01
-0.2673D-01							

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DIAGNOSTIC TABLE 8.. AT TIME = 3.2172D 00 .(DELT = 1.1391D 00)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.1195D 01	0.1214D 00	17
2	0.1432D-01	0.1500D-03	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8315D-01	0.9471D-01	0.2675D 00
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2122D-01	0.2416D-01	0.6823D-01
RAINFALL.	-0.5657D 00	-0.5756D 00	-0.1170D 01
NUMERICAL LOSSES.	0.4664D-02	0.5349D-02	0.1522D-01
NET FLOW.	-0.4567D 00	-0.4513D 00	-0.8189D 00
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9041D 00	0.1030D 01	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1963D-01	0.1481D-02	-0.3402D-03	0.5597D-04	-0.1575D-04	0.9614D-05	0.1883D-04	0.2602D-04
-0.3995D-01	-0.7251D-01	-0.7089D-01	-0.7018D-01	-0.6971D-01	-0.6938D-01	-0.6917D-01	-0.6905D-01
-0.3450D-01							

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DIAGNOSTIC TABLE 9.. AT TIME = 4.9258D 00 .(DELT = 1.7086D 00)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.1316D 01	0.1637D 00	18
2	0.2978D-01	0.3161D-03	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8314D-01	0.1421D 00	0.4096D 00
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2117D-01	0.3622D-01	0.1044D 00
RAINFALL.	-0.6830D 00	-0.1067D 01	-0.2237D 01
NUMERICAL LOSSES.	0.4568D-02	0.7887D-02	0.2311D-01
NET FLOW.	-0.5741D 00	-0.8806D 00	-0.1699D 01
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9041D 00	0.1545D 01	0.3977D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1961D-01	0.1455D-02	-0.3781D-03	0.4891D-04	-0.1440D-04	0.1020D-04	0.1839D-04	0.2637D-04
-0.4547D-01	-0.8694D-01	-0.8564D-01	-0.8504D-01	-0.8467D-01	-0.8440D-01	-0.8423D-01	-0.8413D-01
-0.4205D-01							

DIAGNOSTIC TABLE 1C.. AT TIME = 7.4887D 00 .(DELT = 2.5629D 00)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.1375D 01	0.2054D 00	26
2	0.5578D-01	0.6007D-03	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.8314D-01	0.2131D 00	0.6226D 00
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.2119D-01	0.5428D-01	0.1587D 00
RAINFALL.	-0.7728D 00	-0.1865D 01	-0.4102D 01
NUMERICAL LOSSES.	0.4460D-02	0.1157D-01	0.3468D-01
NET FLOW.	-0.6640D 00	-0.1586D 01	-0.3286D 01
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9041D 00	0.2317D 01	0.3978D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.1959D-01	0.1478D-02	-0.3343D-03	0.6137D-04	-0.1282D-04	0.1043D-04	0.1803D-04	0.2658D-04
-0.4980D-01	-0.9795D-01	-0.9694D-01	-0.9642D-01	-0.9612D-01	-0.9590D-01	-0.9576D-01	-0.9568D-01
-0.4783D-01							

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DIAGNOSTIC TABLE 70.. AT TIME = 1.0443D 04 .(DELT = 2.0000D 02)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.2484D 00	0.8723D-01	26
2	0.1786D-03	0.1249D-03	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.1903D 00	0.3806D 02	0.1620D 04
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1441D 00	0.2880D 02	0.9951D 03
RAINFALL.	-0.3380D 00	-0.6508D 02	-0.5259D 04
NUMERICAL LOSSES.	0.1135D-01	0.2280D 01	0.7993D 02
NET FLOW.	0.7790D-02	0.4061D 01	-0.2564D 04
INCREASE IN VOLUMETRIC WATER CONTENT. .	-0.9655D-04	-0.1931D-01	0.4313D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.5917D-01	0.3748D-01	0.2515D-01	0.1643D-01	0.5556D-02	0.2594D-03	-0.7548D-04	0.5707D-05
-0.5988D-01	-0.6547D-01	-0.4405D-01	-0.3515D-01	-0.3215D-01	-0.3010D-01	-0.2894D-01	-0.2820D-01
-0.1395D-01							

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DIAGNOSTIC TABLE 71.. AT TIME = 1.0643D 04 .(DELT = 2.0000D 02)

TABLE OF ITERATIVE PARAMETERS

ITERATION	RESIDUAL	DEVIATION	NO. NON-CONV. NODES
1	0.2464D 00	0.9437D-01	26
2	0.1872D-03	0.1797D-03	0

TABLE OF SYSTEM-FLOW PARAMETERS

TYPE OF FLOW	RATE	INC. FLOW	TOTAL FLOW
CONSTANT-PRESSURE-NODE FLOW	0.1903D 00	0.3806D 02	0.1658D 04
CONSTANT-FLUX-NODE FLOW	0.0	0.0	0.0
SEEPAGE	0.1439D 00	0.2880D 02	0.1024D 04
RAINFALL.	-0.3131D 00	-0.6511D 02	-0.5324D 04
NUMERICAL LOSSES.	0.1141D-01	0.2280D 01	0.8221D 02
NET FLOW.	0.3256D-01	0.4035D 01	-0.2560D 04
INCREASE IN VOLUMETRIC WATER CONTENT. .	0.9386D-04	0.1877D-01	0.4313D 05

RAINFALL-SEEPAGE NODAL FLOWS

0.5916D-01	0.3744D-01	0.2510D-01	0.1639D-01	0.5538D-02	0.2582D-03	-0.7117D-04	0.1442D-04
-0.6039D-01	-0.6485D-01	-0.4586D-01	-0.3513D-01	-0.2857D-01	-0.2471D-01	-0.2223D-01	-0.2096D-01
-0.1031D-01							

OUTPUT

OUTPUT TABLE 1.. PRESSURE HEADS AT TIME = 1.0643D 04 .(DELT = 2.0000D 02).(BAND WIDTH = 31)

NODE I	PRESSURE HEAD OF NODES I,I+1,....,I+7							
1	1.5162D 02	1.3378D 02	1.1662D 02	1.0029D 02	8.4904D 01	7.0596D 01	5.7482D 01	4.5659D 01
9	3.5208D 01	2.6187D 01	1.6637D 01	1.2582D 01	8.0352D 00	5.0000D 00	1.5230D 02	1.3446D 02
17	1.1730D 02	1.0094D 02	8.5518D 01	7.1153D 01	5.7964D 01	4.6056D 01	3.5517D 01	2.6410D 01
25	1.8781D 01	1.2658D 01	8.0616D 00	5.0000D 00	1.5436D 02	1.3652D 02	1.1934D 02	1.0295D 02
33	8.7446D 01	7.2940D 01	5.9544D 01	4.7373D 01	3.6543D 01	2.7156D 01	1.9284D 01	1.2961D 01
41	8.1974D 00	5.0000D 00	1.5780D 02	1.3997D 02	1.2282D 02	1.0644D 02	9.0915D 01	7.6318D 01
49	6.2719D 01	5.0198D 01	3.8862D 01	2.8847D 01	2.0319D 01	1.3443D 01	8.3329D 00	5.0000D 00
57	1.6254D 02	1.4475D 02	1.2770D 02	1.1148D 02	9.6133D 01	8.1719D 01	6.8267D 01	5.5807D 01
65	4.4362D 01	3.3957D 01	2.4636D 01	1.6516D 01	9.8417D 00	5.0000D 00	1.6479D 02	1.4543D 02
73	1.2691D 02	1.0929D 02	9.2646D 01	7.7019D 01	6.2437D 01	4.8941D 01	3.6601D 01	2.5568D 01
81	1.6109D 01	8.5652D 00	3.1989D 00	0.0	1.6720D 02	1.4629D 02	1.2632D 02	1.0737D 02
89	8.9522D 01	7.2828D 01	5.7371D 01	4.3292D 01	3.0832D 01	2.0327D 01	1.2074D 01	6.1310D 00
97	2.2396D 00	0.0	1.6976D 02	1.4732D 02	1.2594D 02	1.0573D 02	8.6793D 01	6.9241D 01
105	5.3253D 01	3.9116D 01	2.7166D 01	1.7642D 01	1.0501D 01	5.4138D 00	1.9955D 00	0.0
113	1.7245D 02	1.4849D 02	1.2574D 02	1.0435D 02	8.4466D 01	6.6271D 01	5.0060D 01	3.6175D 01
121	2.4857D 01	1.6075D 01	9.5293D 00	4.8485D 00	1.7391D 00	0.0	1.7526D 02	1.4978D 02
129	1.2571D 02	1.0322D 02	8.2507D 01	6.3841D 01	4.7568D 01	3.3970D 01	2.3099D 01	1.4742D 01
137	8.5598D 00	4.2298D 00	1.4627D 00	0.0	1.7815D 02	1.5117D 02	1.2582D 02	1.0230D 02
145	8.0849D 01	6.1805D 01	4.5483D 01	3.2039D 01	2.1360D 01	1.3142D 01	7.0217D 00	2.6513D 00
153	-2.4839D-01	-1.8329D 00	1.8110D 02	1.5264D 02	1.2604D 02	1.0153D 02	7.9411D 01	5.9998D 01
161	4.3544D 01	3.0054D 01	1.9291D 01	1.0879D 01	4.4322D 00	-3.4698D-01	-3.6043D 00	-5.3654D 00
169	1.8411D 02	1.5417D 02	1.2634D 02	1.0089D 02	7.8102D 01	5.8281D 01	4.1558D 01	2.7806D 01
177	1.6689D 01	7.8028D 00	8.2570D-01	-4.4133D 00	-7.9569D 00	-9.8116D 00	1.8714D 02	1.5573D 02
185	1.2670D 02	1.0031D 02	7.6849D 01	5.6542D 01	3.9403D 01	2.5187D 01	1.3507D 01	3.9959D 00
193	-3.5672D 00	-9.2549D 00	-1.3075D 01	-1.5024D 01	1.9019D 02	1.5731D 02	1.2709D 02	9.9762D 01
201	7.5592D 01	5.4712D 01	3.7016D 01	2.2178D 01	9.8024D 00	-4.1990D-01	-8.6464D 00	-1.4911D 01
209	-1.9173D 01	-2.1335D 01	1.9779D 02	1.6354D 02	1.3236D 02	1.0435D 02	7.9598D 01	5.8053D 01
217	3.9494D 01	2.3612D 01	1.0131D 01	-1.1236D 00	-1.0208D 01	-1.7085D 01	-2.1671D 01	-2.3911D 01
225	2.0522D 02	1.6957D 02	1.3732D 02	1.0845D 02	8.2921D 01	6.0555D 01	4.1110D 01	2.4330D 01
233	1.0032D 01	-1.8727D 00	-1.1377D 01	-1.8468D 01	-2.3113D 01	-2.5308D 01	2.1236D 02	1.7529D 02
241	1.4190D 02	1.1209D 02	8.5695D 01	6.2507D 01	4.2275D 01	2.4786D 01	9.8973D 00	-2.4455D 00
249	-1.2262D 01	-1.9527D 01	-2.4282D 01	-2.6476D 01	2.1913D 02	1.8062D 02	1.4606D 02	1.1527D 02
257	8.8029D 01	6.4089D 01	4.3204D 01	2.5169D 01	9.8563D 00	-2.8313D 00	-1.2903D 01	-2.0339D 01
265	-2.5160D 01	-2.7332D 01	2.2548D 02	1.8551D 02	1.4978D 02	1.1802D 02	8.9980D 01	6.5390D 01
273	4.4003D 01	2.5582D 01	9.9821D 00	-2.9177D 00	-1.3142D 01	-2.0719D 01	-2.5634D 01	-2.7819D 01
281	2.3136D 02	1.8995D 02	1.5304D 02	1.2034D 02	9.1561D 01	6.6436D 01	4.4710D 01	2.6134D 01
289	1.0453D 01	-2.4788D 00	-1.2787D 01	-2.0334D 01	-2.5077D 01	-2.7071D 01	2.3675D 02	1.9389D 02
297	1.5581D 02	1.2219D 02	9.2747D 01	6.7194D 01	4.5303D 01	2.6819D 01	1.1446D 01	-1.0119D 00
305	-1.1096D 01	-1.9095D 01	-2.4840D 01	-2.7554D 01	2.4163D 02	1.9880D 02	1.6080D 02	1.2733D 02
313	9.8097D 01	7.2846D 01	5.1378D 01	3.3554D 01	1.9211D 01	8.0525D 00	1.5715D-01	-4.7294D 00
321	-7.0420D 00	-7.7389D 00	2.4598D 02	2.0317D 02	1.6525D 02	1.3188D 02	1.0281D 02	7.7782D 01
329	5.6605D 01	3.9154D 01	2.5298D 01	1.4351D 01	7.6879D 00	3.2594D 00	9.0391D-01	0.0
337	2.4977D 02	2.0698D 02	1.6911D 02	1.3581D 02	1.0685D 02	8.1930D 01	6.0887D 01	4.3465D 01
345	2.9497D 01	1.8757D 01	1.0719D 01	5.0318D 00	1.4777D 00	0.0	2.5300D 02	2.1022D 02
353	1.7239D 02	1.3913D 02	1.1018D 02	8.5273D 01	6.4136D 01	4.6557D 01	3.2227D 01	2.0748D 01
361	1.1975D 01	5.6478D 00	1.6748D 00	0.0	2.5565D 02	2.1288D 02	1.7507D 02	1.4183D 02
369	1.1285D 02	8.7864D 01	6.6527D 01	4.8680D 01	3.3978D 01	2.1989D 01	1.2773D 01	6.0967D 00
377	1.8379D 00	0.0	2.5771D 02	2.1496D 02	1.7716D 02	1.4393D 02	1.1489D 02	8.9794D 01
385	6.8274D 01	5.0142D 01	3.5094D 01	2.2752D 01	1.3227D 01	6.3353D 00	1.9192D 00	0.0
393	2.5919D 02	2.1644D 02	1.7866D 02	1.4542D 02	1.1632D 02	9.1129D 01	6.9464D 01	5.1095D 01
401	3.5778D 01	2.3265D 01	1.3544D 01	6.5092D 00	1.9800D 00	0.0	2.6008D 02	2.1733D 02
409	1.7955D 02	1.4631D 02	1.1717D 02	9.1914D 01	7.0157D 01	5.1638D 01	3.6163D 01	2.3557D 01
417	1.3711D 01	6.5959D 00	2.0081D 00	0.0	2.6038D 02	2.1763D 02	1.7985D 02	1.4661D 02
425	1.1745D 02	9.2173D 01	7.0383D 01	5.1816D 01	3.6296D 01	2.3650D 01	1.3763D 01	6.6204D 00
433	2.0152D 00	0.0						

OUTPUT TABLE 2.. TOTAL HEADS AT TIME = 1.0643D 04 ,(DELT = 2.0000D 02),(BAND WIDTH = 31)

NODE I	TOTAL HEAD OF NODES I,I+1,....,I+7							
1	1.5162D 02	1.5128D 02	1.5037D 02	1.4904D 02	1.4740D 02	1.4560D 02	1.4373D 02	1.4191D 02
9	1.4021D 02	1.3869D 02	1.3739D 02	1.3633D 02	1.3554D 02	1.3500D 02	1.5230D 02	1.5196D 02
17	1.5105D 02	1.4969D 02	1.4802D 02	1.4615D 02	1.4421D 02	1.4231D 02	1.4052D 02	1.3891D 02
25	1.3753D 02	1.3641D 02	1.3556D 02	1.3500D 02	1.5436D 02	1.5402D 02	1.5309D 02	1.5170D 02
33	1.4995D 02	1.4794D 02	1.4579D 02	1.4362D 02	1.4154D 02	1.3966D 02	1.3803D 02	1.3671D 02
41	1.3570D 02	1.3500D 02	1.5780D 02	1.5747D 02	1.5657D 02	1.5519D 02	1.5342D 02	1.5132D 02
49	1.4897D 02	1.4645D 02	1.4386D 02	1.4135D 02	1.3907D 02	1.3719D 02	1.3583D 02	1.3500D 02
57	1.6254D 02	1.6225D 02	1.6145D 02	1.6023D 02	1.5863D 02	1.5672D 02	1.5452D 02	1.5206D 02
65	1.4936D 02	1.4646D 02	1.4339D 02	1.4027D 02	1.3734D 02	1.3500D 02	1.6479D 02	1.6447D 02
73	1.6360D 02	1.6227D 02	1.6053D 02	1.5843D 02	1.5599D 02	1.5327D 02	1.5032D 02	1.4730D 02
81	1.4447D 02	1.4219D 02	1.4070D 02	1.4000D 02	1.6720D 02	1.6687D 02	1.6597D 02	1.6458D 02
89	1.6279D 02	1.6065D 02	1.5824D 02	1.5569D 02	1.5327D 02	1.5129D 02	1.5005D 02	1.4962D 02
97	1.4974D 02	1.5000D 02	1.6976D 02	1.6943D 02	1.6853D 02	1.6717D 02	1.6545D 02	1.6347D 02
105	1.6143D 02	1.5960D 02	1.5832D 02	1.5783D 02	1.5810D 02	1.5878D 02	1.5949D 02	1.6000D 02
113	1.7245D 02	1.7214D 02	1.7129D 02	1.7003D 02	1.6850D 02	1.6691D 02	1.6554D 02	1.6473D 02
121	1.6473D 02	1.6550D 02	1.6674D 02	1.6808D 02	1.6924D 02	1.7000D 02	1.7526D 02	1.7497D 02
129	1.7420D 02	1.7313D 02	1.7193D 02	1.7089D 02	1.7036D 02	1.7060D 02	1.7169D 02	1.7339D 02
137	1.7539D 02	1.7734D 02	1.7896D 02	1.8000D 02	1.7815D 02	1.7790D 02	1.7726D 02	1.7643D 02
145	1.7566D 02	1.7527D 02	1.7558D 02	1.7675D 02	1.7867D 02	1.8103D 02	1.8346D 02	1.8563D 02
153	1.8725D 02	1.8817D 02	1.8110D 02	1.8091D 02	1.8043D 02	1.7990D 02	1.7960D 02	1.7987D 02
161	1.8095D 02	1.8284D 02	1.8532D 02	1.8799D 02	1.9049D 02	1.9251D 02	1.9389D 02	1.9463D 02
169	1.8411D 02	1.8397D 02	1.8368D 02	1.8348D 02	1.8368D 02	1.8456D 02	1.8627D 02	1.8867D 02
177	1.9143D 02	1.9415D 02	1.9650D 02	1.9831D 02	1.9954D 02	2.0019D 02	1.8714D 02	1.8708D 02
185	1.8699D 02	1.8714D 02	1.8781D 02	1.8923D 02	1.9142D 02	1.9413D 02	1.9697D 02	1.9957D 02
193	2.0172D 02	2.0334D 02	2.0442D 02	2.0498D 02	1.9019D 02	1.9020D 02	1.9033D 02	1.9082D 02
201	1.9194D 02	1.9381D 02	1.9634D 02	1.9920D 02	2.0198D 02	2.0439D 02	2.0626D 02	2.0756D 02
209	2.0833D 02	2.0866D 02	1.9779D 02	1.9796D 02	1.9854D 02	1.9963D 02	2.0133D 02	2.0357D 02
217	2.0613D 02	2.0871D 02	2.1103D 02	2.1291D 02	2.1431D 02	2.1525D 02	2.1583D 02	2.1609D 02
225	2.0522D 02	2.0553D 02	2.0645D 02	2.0797D 02	2.1004D 02	2.1248D 02	2.1505D 02	2.1750D 02
233	2.1965D 02	2.2140D 02	2.2276D 02	2.2374D 02	2.2439D 02	2.2469D 02	2.1236D 02	2.1279D 02
241	2.1398D 02	2.1584D 02	2.1819D 02	2.2084D 02	2.2352D 02	2.2604D 02	2.2823D 02	2.3005D 02
249	2.3149D 02	2.3256D 02	2.3322D 02	2.3352D 02	2.1913D 02	2.1965D 02	2.2109D 02	2.2325D 02
257	2.2591D 02	2.2883D 02	2.3176D 02	2.3450D 02	2.3691D 02	2.3890D 02	2.4046D 02	2.4162D 02
265	2.4234D 02	2.4267D 02	2.2548D 02	2.2609D 02	2.2776D 02	2.3023D 02	2.3325D 02	2.3654D 02
273	2.3987D 02	2.4299D 02	2.4575D 02	2.4804D 02	2.4984D 02	2.5111D 02	2.5186D 02	2.5218D 02
281	2.3136D 02	2.3206D 02	2.3397D 02	2.3678D 02	2.4022D 02	2.4400D 02	2.4788D 02	2.5161D 02
289	2.5494D 02	2.5771D 02	2.5981D 02	2.6136D 02	2.6242D 02	2.6293D 02	2.3675D 02	2.3754D 02
297	2.3968D 02	2.4286D 02	2.4678D 02	2.5117D 02	2.5578D 02	2.6038D 02	2.6465D 02	2.6841D 02
305	2.7112D 02	2.7248D 02	2.7266D 02	2.7245D 02	2.4163D 02	2.4245D 02	2.4468D 02	2.4800D 02
313	2.5214D 02	2.5682D 02	2.6186D 02	2.6711D 02	2.7242D 02	2.7748D 02	2.8237D 02	2.8684D 02
321	2.9046D 02	2.9226D 02	2.4598D 02	2.4683D 02	2.4912D 02	2.5255D 02	2.5685D 02	2.6176D 02
329	2.6709D 02	2.7271D 02	2.7850D 02	2.8427D 02	2.8990D 02	2.9483D 02	2.9840D 02	3.0000D 02
337	2.4977D 02	2.5064D 02	2.5299D 02	2.5649D 02	2.6088D 02	2.6590D 02	2.7137D 02	2.7702D 02
345	2.8270D 02	2.8818D 02	2.9293D 02	2.9660D 02	2.9898D 02	3.0000D 02	2.5300D 02	2.5388D 02
353	2.5626D 02	2.5980D 02	2.6422D 02	2.6925D 02	2.7462D 02	2.8011D 02	2.8543D 02	2.9017D 02
361	2.9419D 02	2.9722D 02	2.9917D 02	3.0000D 02	2.5565D 02	2.5654D 02	2.5895D 02	2.6251D 02
369	2.6689D 02	2.7184D 02	2.7701D 02	2.8224D 02	2.8718D 02	2.9141D 02	2.9458D 02	2.9767D 02
377	2.9934D 02	3.0000D 02	2.5771D 02	2.5861D 02	2.6104D 02	2.6460D 02	2.6893D 02	2.7377D 02
385	2.7875D 02	2.8370D 02	2.8830D 02	2.9217D 02	2.9544D 02	2.9791D 02	2.9942D 02	3.0000D 02
393	2.5919D 02	2.6010D 02	2.6253D 02	2.6609D 02	2.7036D 02	2.7510D 02	2.7995D 02	2.8465D 02
401	2.8898D 02	2.9269D 02	2.9575D 02	2.9808D 02	2.9948D 02	3.0000D 02	2.6008D 02	2.6099D 02
409	2.6343D 02	2.6699D 02	2.7121D 02	2.7589D 02	2.8064D 02	2.8520D 02	2.8937D 02	2.9298D 02
417	2.9592D 02	2.9817D 02	2.9951D 02	3.0000D 02	2.6038D 02	2.6128D 02	2.6373D 02	2.6728D 02
425	2.7149D 02	2.7615D 02	2.8086D 02	2.8537D 02	2.8950D 02	2.9307D 02	2.9597D 02	2.9819D 02
433	2.9951D 02	3.0000D 02						

OUTPUT TABLE 3.. WATER CONTENTS AT TIME = 1.0643D 04 .(DELT = 2.0000D 02).(BAND WIDTH = 31)

	NODES			
ELEMENT	1	2	3	4
1	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
2	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
3	2.9950D-01	2.9950D-01	2.9950D-01	2.9950D-01
4	2.9950D-01	2.9950D-01	2.9892D-01	2.9890D-01
5	2.9890D-01	2.9892D-01	2.9835D-01	2.9832D-01
6	2.9832D-01	2.9835D-01	2.9782D-01	2.9780D-01
7	2.9780D-01	2.9782D-01	2.9711D-01	2.9707D-01
8	2.9707D-01	2.9711D-01	2.9605D-01	2.9602D-01
9	2.9602D-01	2.9605D-01	2.9514D-01	2.9512D-01
10	2.9512D-01	2.9514D-01	2.9438D-01	2.9436D-01
11	2.9436D-01	2.9438D-01	2.9377D-01	2.9376D-01
12	2.9376D-01	2.9377D-01	2.9331D-01	2.9330D-01
13	2.9330D-01	2.9331D-01	2.9300D-01	2.9300D-01
14	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
15	2.9951D-01	2.9951D-01	2.9951D-01	2.9950D-01
16	2.9950D-01	2.9951D-01	2.9950D-01	2.9950D-01
17	2.9950D-01	2.9950D-01	2.9900D-01	2.9892D-01
18	2.9892D-01	2.9900D-01	2.9842D-01	2.9835D-01
19	2.9835D-01	2.9842D-01	2.9788D-01	2.9782D-01
20	2.9782D-01	2.9788D-01	2.9724D-01	2.9711D-01
21	2.9711D-01	2.9724D-01	2.9615D-01	2.9605D-01
22	2.9605D-01	2.9615D-01	2.9522D-01	2.9514D-01
23	2.9514D-01	2.9522D-01	2.9443D-01	2.9438D-01
24	2.9438D-01	2.9443D-01	2.9380D-01	2.9377D-01
25	2.9377D-01	2.9380D-01	2.9332D-01	2.9331D-01
26	2.9331D-01	2.9332D-01	2.9300D-01	2.9300D-01
27	2.9951D-01	2.9952D-01	2.9951D-01	2.9951D-01
28	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
29	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
30	2.9950D-01	2.9950D-01	2.9914D-01	2.9900D-01
31	2.9900D-01	2.9914D-01	2.9855D-01	2.9842D-01
32	2.9842D-01	2.9855D-01	2.9801D-01	2.9788D-01
33	2.9788D-01	2.9801D-01	2.9751D-01	2.9724D-01
34	2.9724D-01	2.9751D-01	2.9639D-01	2.9615D-01
35	2.9615D-01	2.9639D-01	2.9538D-01	2.9522D-01
36	2.9522D-01	2.9538D-01	2.9453D-01	2.9443D-01
37	2.9443D-01	2.9453D-01	2.9384D-01	2.9380D-01
38	2.9380D-01	2.9384D-01	2.9333D-01	2.9332D-01
39	2.9332D-01	2.9333D-01	2.9300D-01	2.9300D-01
40	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
41	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
42	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
43	2.9950D-01	2.9950D-01	2.9935D-01	2.9914D-01
44	2.9914D-01	2.9935D-01	2.9877D-01	2.9855D-01
45	2.9855D-01	2.9877D-01	2.9823D-01	2.9801D-01
46	2.9801D-01	2.9823D-01	2.9773D-01	2.9751D-01
47	2.9751D-01	2.9773D-01	2.9694D-01	2.9639D-01
48	2.9639D-01	2.9694D-01	2.9590D-01	2.9538D-01
49	2.9538D-01	2.9590D-01	2.9496D-01	2.9453D-01
50	2.9453D-01	2.9496D-01	2.9415D-01	2.9384D-01
51	2.9384D-01	2.9415D-01	2.9348D-01	2.9333D-01
52	2.9333D-01	2.9348D-01	2.9300D-01	2.9300D-01
53	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
54	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
55	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
56	2.9950D-01	2.9950D-01	2.9921D-01	2.9935D-01

57	2.9935D-01	2.9921D-01	2.9858D-01	2.9877D-01
58	2.9877D-01	2.9858D-01	2.9800D-01	2.9823D-01
59	2.9823D-01	2.9800D-01	2.9739D-01	2.9773D-01
60	2.9773D-01	2.9739D-01	2.9616D-01	2.9694D-01
61	2.9694D-01	2.9616D-01	2.9506D-01	2.9590D-01
62	2.9590D-01	2.9506D-01	2.9411D-01	2.9496D-01
63	2.9496D-01	2.9411D-01	2.9336D-01	2.9415D-01
64	2.9415D-01	2.9336D-01	2.9282D-01	2.9348D-01
65	2.9348D-01	2.9282D-01	2.9250D-01	2.9300D-01
66	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
67	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
68	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
69	2.9950D-01	2.9950D-01	2.9908D-01	2.9921D-01
70	2.9921D-01	2.9908D-01	2.9841D-01	2.9858D-01
71	2.9858D-01	2.9841D-01	2.9779D-01	2.9800D-01
72	2.9800D-01	2.9779D-01	2.9683D-01	2.9739D-01
73	2.9739D-01	2.9683D-01	2.9558D-01	2.9616D-01
74	2.9616D-01	2.9558D-01	2.9453D-01	2.9506D-01
75	2.9506D-01	2.9453D-01	2.9371D-01	2.9411D-01
76	2.9411D-01	2.9371D-01	2.9311D-01	2.9336D-01
77	2.9336D-01	2.9311D-01	2.9272D-01	2.9282D-01
78	2.9282D-01	2.9272D-01	2.9250D-01	2.9250D-01
79	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
80	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
81	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
82	2.9950D-01	2.9950D-01	2.9897D-01	2.9908D-01
83	2.9908D-01	2.9897D-01	2.9827D-01	2.9841D-01
84	2.9841D-01	2.9827D-01	2.9763D-01	2.9779D-01
85	2.9779D-01	2.9763D-01	2.9641D-01	2.9683D-01
86	2.9683D-01	2.9641D-01	2.9522D-01	2.9558D-01
87	2.9558D-01	2.9522D-01	2.9426D-01	2.9453D-01
88	2.9453D-01	2.9426D-01	2.9355D-01	2.9371D-01
89	2.9371D-01	2.9355D-01	2.9304D-01	2.9311D-01
90	2.9311D-01	2.9304D-01	2.9270D-01	2.9272D-01
91	2.9272D-01	2.9270D-01	2.9250D-01	2.9250D-01
92	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
93	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
94	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
95	2.9950D-01	2.9950D-01	2.9888D-01	2.9897D-01
96	2.9897D-01	2.9888D-01	2.9815D-01	2.9827D-01
97	2.9827D-01	2.9815D-01	2.9750D-01	2.9763D-01
98	2.9763D-01	2.9750D-01	2.9612D-01	2.9641D-01
99	2.9641D-01	2.9612D-01	2.9499D-01	2.9522D-01
100	2.9522D-01	2.9499D-01	2.9411D-01	2.9426D-01
101	2.9426D-01	2.9411D-01	2.9345D-01	2.9355D-01
102	2.9355D-01	2.9345D-01	2.9298D-01	2.9304D-01
103	2.9304D-01	2.9298D-01	2.9267D-01	2.9270D-01
104	2.9270D-01	2.9267D-01	2.9250D-01	2.9250D-01
105	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
106	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
107	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
108	2.9950D-01	2.9950D-01	2.9880D-01	2.9888D-01
109	2.9888D-01	2.9880D-01	2.9805D-01	2.9815D-01
110	2.9815D-01	2.9805D-01	2.9726D-01	2.9750D-01
111	2.9750D-01	2.9726D-01	2.9590D-01	2.9612D-01
112	2.9612D-01	2.9590D-01	2.9481D-01	2.9499D-01
113	2.9499D-01	2.9481D-01	2.9397D-01	2.9411D-01
114	2.9411D-01	2.9397D-01	2.9336D-01	2.9345D-01
115	2.9345D-01	2.9336D-01	2.9292D-01	2.9298D-01
116	2.9298D-01	2.9292D-01	2.9265D-01	2.9267D-01
117	2.9267D-01	2.9265D-01	2.9250D-01	2.9250D-01
118	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
119	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
120	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
121	2.9950D-01	2.9950D-01	2.9873D-01	2.9880D-01
122	2.9880D-01	2.9873D-01	2.9797D-01	2.9805D-01

123	2.9805D-01	2.9797D-01	2.9705D-01	2.9726C-01
124	2.9726D-01	2.9705D-01	2.9570D-01	2.9590C-01
125	2.9590D-01	2.9570D-01	2.9464D-01	2.9481D-01
126	2.9481D-01	2.9464D-01	2.9381D-01	2.9397C-01
127	2.9397D-01	2.9381D-01	2.9320D-01	2.9336C-01
128	2.9336D-01	2.9320D-01	2.9277D-01	2.9292C-01
129	2.9292D-01	2.9277D-01	2.9245D-01	2.9265C-01
130	2.9265D-01	2.9245D-01	2.9213D-01	2.9250C-01
131	2.9952D-01	2.9952D-01	2.9951D-01	2.9951C-01
132	2.9951D-01	2.9951D-01	2.9951D-01	2.9951C-01
133	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
134	2.9950D-01	2.9950D-01	2.9868D-01	2.9873C-01
135	2.9873D-01	2.9868D-01	2.9790D-01	2.9797C-01
136	2.9797D-01	2.9790D-01	2.9685D-01	2.9705C-01
137	2.9705D-01	2.9685D-01	2.9551D-01	2.9570C-01
138	2.9570D-01	2.9551D-01	2.9443D-01	2.9464C-01
139	2.9464D-01	2.9443D-01	2.9359D-01	2.9381C-01
140	2.9381D-01	2.9359D-01	2.9294D-01	2.9320C-01
141	2.9320D-01	2.9294D-01	2.9243D-01	2.9277C-01
142	2.9277D-01	2.9243D-01	2.9178D-01	2.9245C-01
143	2.9245D-01	2.9178D-01	2.9143D-01	2.9213C-01
144	2.9952D-01	2.9952D-01	2.9951D-01	2.9951C-01
145	2.9951D-01	2.9951D-01	2.9951D-01	2.9951C-01
146	2.9951D-01	2.9951D-01	2.9950D-01	2.9950C-01
147	2.9950D-01	2.9950D-01	2.9862D-01	2.9868C-01
148	2.9868D-01	2.9862D-01	2.9785D-01	2.9790C-01
149	2.9790D-01	2.9783D-01	2.9666D-01	2.9685C-01
150	2.9685D-01	2.9666D-01	2.9528D-01	2.9551C-01
151	2.9551D-01	2.9528D-01	2.9417D-01	2.9443C-01
152	2.9443D-01	2.9417D-01	2.9328D-01	2.9359C-01
153	2.9359D-01	2.9328D-01	2.9258D-01	2.9294C-01
154	2.9294D-01	2.9258D-01	2.9162D-01	2.9243C-01
155	2.9243D-01	2.9162D-01	2.9091D-01	2.9178C-01
156	2.9178D-01	2.9091D-01	2.9054D-01	2.9143C-01
157	2.9952D-01	2.9952D-01	2.9951D-01	2.9951C-01
158	2.9951D-01	2.9951D-01	2.9951D-01	2.9951C-01
159	2.9951D-01	2.9951D-01	2.9950D-01	2.9950C-01
160	2.9950D-01	2.9950D-01	2.9857D-01	2.9862C-01
161	2.9862D-01	2.9857D-01	2.9776D-01	2.9783C-01
162	2.9783D-01	2.9776D-01	2.9644D-01	2.9666D-01
163	2.9666D-01	2.9644D-01	2.9502D-01	2.9528C-01
164	2.9528D-01	2.9502D-01	2.9385D-01	2.9417C-01
165	2.9417D-01	2.9385D-01	2.9290D-01	2.9328C-01
166	2.9328D-01	2.9290D-01	2.9179D-01	2.9258C-01
167	2.9258D-01	2.9179D-01	2.9065D-01	2.9162C-01
168	2.9162D-01	2.9065D-01	2.8977D-01	2.9091C-01
169	2.9091D-01	2.8977D-01	2.8899D-01	2.9054C-01
170	2.9952D-01	2.9952D-01	2.9952D-01	2.9951C-01
171	2.9951D-01	2.9952D-01	2.9951D-01	2.9951C-01
172	2.9951D-01	2.9951D-01	2.9949D-01	2.9950C-01
173	2.9950D-01	2.9949D-01	2.9852D-01	2.9857C-01
174	2.9857D-01	2.9852D-01	2.9769D-01	2.9776C-01
175	2.9776D-01	2.9769D-01	2.9620D-01	2.9644C-01
176	2.9644D-01	2.9620D-01	2.9472D-01	2.9502C-01
177	2.9502D-01	2.9472D-01	2.9348D-01	2.9385D-01
178	2.9385D-01	2.9348D-01	2.9242D-01	2.9290C-01
179	2.9290D-01	2.9242D-01	2.9077D-01	2.9179C-01
180	2.9179D-01	2.9077D-01	2.8904D-01	2.9065C-01
181	2.9065D-01	2.8904D-01	2.8733D-01	2.8977C-01
182	2.8977D-01	2.8733D-01	2.8647D-01	2.8899C-01
183	2.9952D-01	2.9953D-01	2.9952D-01	2.9952C-01
184	2.9952D-01	2.9952D-01	2.9951D-01	2.9951C-01
185	2.9951D-01	2.9951D-01	2.9950D-01	2.9949C-01
186	2.9949D-01	2.9950D-01	2.9868D-01	2.9852C-01
187	2.9852D-01	2.9868D-01	2.9782D-01	2.9769C-01
188	2.9769D-01	2.9782D-01	2.9645D-01	2.9620C-01

189	2.9620D-01	2.9645D-01	2.9486D-01	2.9472D-01
190	2.9472D-01	2.9486D-01	2.9351D-01	2.9348D-01
191	2.9348D-01	2.9351D-01	2.9228D-01	2.9242D-01
192	2.9242D-01	2.9228D-01	2.9046D-01	2.9077D-01
193	2.9077D-01	2.9046D-01	2.8817D-01	2.8904D-01
194	2.8904D-01	2.8817D-01	2.8633D-01	2.8733D-01
195	2.8733D-01	2.8633D-01	2.8544D-01	2.8647D-01
196	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
197	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
198	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
199	2.9950D-01	2.9950D-01	2.9882D-01	2.9868D-01
200	2.9868D-01	2.9882D-01	2.9792D-01	2.9782D-01
201	2.9782D-01	2.9792D-01	2.9661D-01	2.9645D-01
202	2.9645D-01	2.9661D-01	2.9493D-01	2.9486D-01
203	2.9486D-01	2.9493D-01	2.9350D-01	2.9351D-01
204	2.9351D-01	2.9350D-01	2.9213D-01	2.9228D-01
205	2.9228D-01	2.9213D-01	2.9022D-01	2.9046D-01
206	2.9046D-01	2.9022D-01	2.8761D-01	2.8817D-01
207	2.8817D-01	2.8761D-01	2.8575D-01	2.8633D-01
208	2.8633D-01	2.8575D-01	2.8475D-01	2.8544D-01
209	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
210	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
211	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
212	2.9950D-01	2.9950D-01	2.9893D-01	2.9882D-01
213	2.9882D-01	2.9893D-01	2.9800D-01	2.9792D-01
214	2.9792D-01	2.9800D-01	2.9673D-01	2.9661D-01
215	2.9661D-01	2.9673D-01	2.9498D-01	2.9493D-01
216	2.9493D-01	2.9498D-01	2.9349D-01	2.9350D-01
217	2.9350D-01	2.9349D-01	2.9201D-01	2.9213D-01
218	2.9213D-01	2.9201D-01	2.9005D-01	2.9022D-01
219	2.9022D-01	2.9005D-01	2.8719D-01	2.8761D-01
220	2.8761D-01	2.8719D-01	2.8529D-01	2.8575D-01
221	2.8575D-01	2.8529D-01	2.8382D-01	2.8475D-01
222	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
223	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
224	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
225	2.9950D-01	2.9950D-01	2.9902D-01	2.9893D-01
226	2.9893D-01	2.9902D-01	2.9806D-01	2.9800D-01
227	2.9800D-01	2.9806D-01	2.9682D-01	2.9673D-01
228	2.9673D-01	2.9682D-01	2.9502D-01	2.9498D-01
229	2.9498D-01	2.9502D-01	2.9349D-01	2.9349D-01
230	2.9349D-01	2.9349D-01	2.9193D-01	2.9201D-01
231	2.9201D-01	2.9193D-01	2.8984D-01	2.9005D-01
232	2.9005D-01	2.8984D-01	2.8686D-01	2.8719D-01
233	2.8719D-01	2.8686D-01	2.8487D-01	2.8529D-01
234	2.8529D-01	2.8487D-01	2.8313D-01	2.8382D-01
235	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
236	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
237	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
238	2.9950D-01	2.9950D-01	2.9910D-01	2.9902D-01
239	2.9902D-01	2.9910D-01	2.9812D-01	2.9806D-01
240	2.9806D-01	2.9812D-01	2.9690D-01	2.9682D-01
241	2.9682D-01	2.9690D-01	2.9506D-01	2.9502D-01
242	2.9502D-01	2.9506D-01	2.9350D-01	2.9349D-01
243	2.9349D-01	2.9350D-01	2.9192D-01	2.9193D-01
244	2.9193D-01	2.9192D-01	2.8974D-01	2.8984D-01
245	2.8984D-01	2.8974D-01	2.8671D-01	2.8686D-01
246	2.8686D-01	2.8671D-01	2.8449D-01	2.8487D-01
247	2.8487D-01	2.8449D-01	2.8274D-01	2.8313D-01
248	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
249	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
250	2.9951D-01	2.9951D-01	2.9951D-01	2.9950D-01
251	2.9950D-01	2.9951D-01	2.9916D-01	2.9910D-01
252	2.9910D-01	2.9916D-01	2.9816D-01	2.9812D-01
253	2.9812D-01	2.9816D-01	2.9697D-01	2.9690D-01
254	2.9690D-01	2.9697D-01	2.9511D-01	2.9506D-01

255	2.9506D-01	2.9511D-01	2.9355D-01	2.9350D-01
256	2.9350D-01	2.9355D-01	2.9200D-01	2.9192D-01
257	2.9192D-01	2.9200D-01	2.8989D-01	2.8974D-01
258	2.8974D-01	2.8989D-01	2.8687D-01	2.8671D-01
259	2.8671D-01	2.8687D-01	2.8494D-01	2.8449D-01
260	2.8449D-01	2.8494D-01	2.8334D-01	2.8274D-01
261	2.9953D-01	2.9954D-01	2.9952D-01	2.9952D-01
262	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
263	2.9951D-01	2.9951D-01	2.9951D-01	2.9951D-01
264	2.9951D-01	2.9951D-01	2.9921D-01	2.9916D-01
265	2.9916D-01	2.9921D-01	2.9819D-01	2.9816D-01
266	2.9816D-01	2.9819D-01	2.9703D-01	2.9697D-01
267	2.9697D-01	2.9703D-01	2.9518D-01	2.9511D-01
268	2.9511D-01	2.9518D-01	2.9364D-01	2.9355D-01
269	2.9355D-01	2.9364D-01	2.9230D-01	2.9200D-01
270	2.9200D-01	2.9230D-01	2.9028D-01	2.8989D-01
271	2.8989D-01	2.9028D-01	2.8736D-01	2.8687D-01
272	2.8687D-01	2.8736D-01	2.8506D-01	2.8494D-01
273	2.8494D-01	2.8506D-01	2.8296D-01	2.8334D-01
274	2.9954D-01	2.9954D-01	2.9953D-01	2.9952D-01
275	2.9952D-01	2.9953D-01	2.9952D-01	2.9951D-01
276	2.9951D-01	2.9952D-01	2.9951D-01	2.9951D-01
277	2.9951D-01	2.9951D-01	2.9942D-01	2.9921D-01
278	2.9921D-01	2.9942D-01	2.9841D-01	2.9819D-01
279	2.9819D-01	2.9841D-01	2.9756D-01	2.9703D-01
280	2.9703D-01	2.9756D-01	2.9586D-01	2.9518D-01
281	2.9518D-01	2.9586D-01	2.9442D-01	2.9364D-01
282	2.9364D-01	2.9442D-01	2.9331D-01	2.9230D-01
283	2.9230D-01	2.9331D-01	2.9252D-01	2.9028D-01
284	2.9028D-01	2.9252D-01	2.9155D-01	2.8736D-01
285	2.8736D-01	2.9155D-01	2.9109D-01	2.8506D-01
286	2.8506D-01	2.9109D-01	2.9095D-01	2.8296D-01
287	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
288	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
289	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
290	2.9951D-01	2.9951D-01	2.9950D-01	2.9942D-01
291	2.9942D-01	2.9950D-01	2.9861D-01	2.9841D-01
292	2.9841D-01	2.9861D-01	2.9776D-01	2.9756D-01
293	2.9756D-01	2.9776D-01	2.9642D-01	2.9586D-01
294	2.9586D-01	2.9642D-01	2.9503D-01	2.9442D-01
295	2.9442D-01	2.9503D-01	2.9399D-01	2.9331D-01
296	2.9331D-01	2.9399D-01	2.9327D-01	2.9252D-01
297	2.9252D-01	2.9327D-01	2.9283D-01	2.9155D-01
298	2.9155D-01	2.9283D-01	2.9259D-01	2.9109D-01
299	2.9109D-01	2.9259D-01	2.9250D-01	2.9095D-01
300	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
301	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
302	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
303	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
304	2.9950D-01	2.9950D-01	2.9878D-01	2.9861D-01
305	2.9861D-01	2.9878D-01	2.9794D-01	2.9776D-01
306	2.9776D-01	2.9794D-01	2.9685D-01	2.9642D-01
307	2.9642D-01	2.9685D-01	2.9545D-01	2.9503D-01
308	2.9503D-01	2.9545D-01	2.9438D-01	2.9399D-01
309	2.9399D-01	2.9438D-01	2.9357D-01	2.9327D-01
310	2.9327D-01	2.9357D-01	2.9300D-01	2.9283D-01
311	2.9283D-01	2.9300D-01	2.9265D-01	2.9259D-01
312	2.9259D-01	2.9265D-01	2.9250D-01	2.9250D-01
313	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
314	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
315	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
316	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
317	2.9950D-01	2.9950D-01	2.9891D-01	2.9878D-01
318	2.9878D-01	2.9891D-01	2.9807D-01	2.9794D-01
319	2.9794D-01	2.9807D-01	2.9716D-01	2.9685D-01
320	2.9685D-01	2.9716D-01	2.9572D-01	2.9545D-01

321	2.9545D-01	2.9572D-01	2.9457D-01	2.9438D-01
322	2.9438D-01	2.9457D-01	2.9370D-01	2.9357D-01
323	2.9357D-01	2.9370D-01	2.9306D-01	2.9300D-01
324	2.9300D-01	2.9306D-01	2.9267D-01	2.9265D-01
325	2.9265D-01	2.9267D-01	2.9250D-01	2.9250D-01
326	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
327	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
328	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
329	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
330	2.9950D-01	2.9950D-01	2.9901D-01	2.9891D-01
331	2.9891D-01	2.9901D-01	2.9816D-01	2.9807D-01
332	2.9807D-01	2.9816D-01	2.9737D-01	2.9716D-01
333	2.9716D-01	2.9737D-01	2.9590D-01	2.9572D-01
334	2.9572D-01	2.9590D-01	2.9470D-01	2.9457D-01
335	2.9457D-01	2.9470D-01	2.9378D-01	2.9370D-01
336	2.9370D-01	2.9378D-01	2.9311D-01	2.9306D-01
337	2.9306D-01	2.9311D-01	2.9268D-01	2.9267D-01
338	2.9267D-01	2.9268D-01	2.9250D-01	2.9250D-01
339	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
340	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
341	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
342	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
343	2.9950D-01	2.9950D-01	2.9909D-01	2.9901D-01
344	2.9901D-01	2.9909D-01	2.9823D-01	2.9816D-01
345	2.9816D-01	2.9823D-01	2.9751D-01	2.9737D-01
346	2.9737D-01	2.9751D-01	2.9601D-01	2.9590D-01
347	2.9590D-01	2.9601D-01	2.9478D-01	2.9470D-01
348	2.9470D-01	2.9478D-01	2.9382D-01	2.9378D-01
349	2.9378D-01	2.9382D-01	2.9313D-01	2.9311D-01
350	2.9311D-01	2.9313D-01	2.9269D-01	2.9268D-01
351	2.9268D-01	2.9269D-01	2.9250D-01	2.9250D-01
352	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
353	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
354	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
355	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
356	2.9950D-01	2.9950D-01	2.9915D-01	2.9909D-01
357	2.9909D-01	2.9915D-01	2.9828D-01	2.9823D-01
358	2.9823D-01	2.9828D-01	2.9754D-01	2.9751D-01
359	2.9751D-01	2.9754D-01	2.9608D-01	2.9601D-01
360	2.9601D-01	2.9608D-01	2.9483D-01	2.9478D-01
361	2.9478D-01	2.9483D-01	2.9385D-01	2.9382D-01
362	2.9382D-01	2.9385D-01	2.9315D-01	2.9313D-01
363	2.9313D-01	2.9315D-01	2.9270D-01	2.9269D-01
364	2.9269D-01	2.9270D-01	2.9250D-01	2.9250D-01
365	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
366	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
367	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
368	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
369	2.9950D-01	2.9950D-01	2.9918D-01	2.9915D-01
370	2.9915D-01	2.9918D-01	2.9831D-01	2.9828D-01
371	2.9828D-01	2.9831D-01	2.9757D-01	2.9754D-01
372	2.9754D-01	2.9757D-01	2.9612D-01	2.9608D-01
373	2.9608D-01	2.9612D-01	2.9486D-01	2.9483D-01
374	2.9483D-01	2.9486D-01	2.9387D-01	2.9385D-01
375	2.9385D-01	2.9387D-01	2.9316D-01	2.9315D-01
376	2.9315D-01	2.9316D-01	2.9270D-01	2.9270D-01
377	2.9270D-01	2.9270D-01	2.9250D-01	2.9250D-01
378	2.9954D-01	2.9954D-01	2.9953D-01	2.9953D-01
379	2.9953D-01	2.9953D-01	2.9952D-01	2.9952D-01
380	2.9952D-01	2.9952D-01	2.9951D-01	2.9951D-01
381	2.9951D-01	2.9951D-01	2.9950D-01	2.9950D-01
382	2.9950D-01	2.9950D-01	2.9919D-01	2.9918D-01
383	2.9918D-01	2.9919D-01	2.9832D-01	2.9831D-01
384	2.9831D-01	2.9832D-01	2.9757D-01	2.9757D-01
385	2.9757D-01	2.9757D-01	2.9613D-01	2.9612D-01
386	2.9612D-01	2.9613D-01	2.9486D-01	2.9486D-01

387	2.9486D-01	2.9486D-01	2.9388D-01	2.9387D-01
388	2.9387D-01	2.9388D-01	2.9316D-01	2.9316D-01
389	2.9316D-01	2.9316D-01	2.9270D-01	2.9270D-01
390	2.9270D-01	2.9270D-01	2.9250D-01	2.9250D-01

APPENDIX C

LISTING OF MOISTURE-TRANSPORT CODE

```
C
C
C
C  PROGRAM AUTHORS--M. REEVES AND J.O. DUGUID, OAK RIDGE NATIONAL
C  LABORATORY, OAK RIDGE, TENNESSEE 37830.
C
C
C
C  FUNCTION OF PROGRAM--TO SIMULATE TRANSIENT TWO-DIMENSIONAL MOISTURE
C  FLOW IN SATURATED/UNSATURATED POROUS MEDIA USING THE GALERKIN METHOD
C  WITH FINITE ELEMENTS Q4.
C
C
C  FUNCTION OF MAIN ROUTINE--TO CONTROL THE INTEGRATION OF THE
C  MOISTURE-FLOW EQUATION, WHICH CONSISTS OF ASSEMBLY, APPLICATION
C  OF BOUNDARY CONDITIONS, MATRIX SOLUTION OF THE RESULTING SET
C  OF EQUATIONS, AND ITERATION BOTH FOR STEADY-STATE AND FOR TRANSIENT
C  CASES.
C
C
C  DIMENSIONING FORMAT--
C
C  COMMON/GEOM/X(MAXNP),Z(MAXNP),BB(MAXNP),DCOSXB(MAXEL),DCOSZB(MAXEL),
C  DLB(MAXEL),NN(MAXNP),NPST(MAXNP),NBE(MAXEL),IE(MAXEL,5),ISB(MAXEL,4)
C
C  COMMON/RFSP/DCYFLX(MAXNP),HCON(MAXNP),FLX(MAXNP),DCOSX(MAXEL),
C  DCOSZ(MAXEL),DL(MAXEL),TRF(MXRFPR,MXRPAR),RF(MXRFPR,MXRPAR),
C  RFALL(MXRFPR),IRFTYP(MAXNP),NPRS(MAXNP),NPCON(MAXNP),NPFLX(MAXNP),
C  NRSE(MAXEL),IS(MAXEL,4)
C
C  COMMON/MTL/PROP(MAXMAT,NMPPM),THPROP(MAXMAT,MXSPPM),
C  AKPROP(MAXMAT,MXSPPM),HPROP(MAXMAT,MXSPPM),CAPROP(MAXMAT,NMPPM)
C
C  DIMENSION R(MAXNP),RP(MAXNP),H(MAXNP),HP(MAXNP),HT(MAXNP),HW(MAXNP),
C  BFLXP(MAXNP),BFLX(MAXNP),RSFLX(MAXNP),NPCNV(MAXNP),C(MAXNP,MAXHBP),
C  TH(MAXEL,4),DTH(MAXEL,4),AKX(MAXEL,4),AKZ(MAXEL,4),VX(MAXEL,4),
C  VZ(MAXEL,4),KPR(MAXNTI),PMAT(3,NMPPM),THPAR(3,NTHPPM),AKPAR(3,NAKPPM)
C  ,SUBHD(8,3),FRATE(10),FLOW(10),TFLOW(10),TITLE(9)
C
C  COMMON/GEOM/ APPEARS IN THE FOLLOWING ROUTINES--MAIN,DATAIN,VELT,
C  BCPREP,BC,ASEMBL,SPROP,STORE,SURF,SFLOW
C
C  COMMON/RFSP/ APPEARS IN THE FOLLOWING ROUTINES--MAIN,DATAIN,BCPREP,
C  BC,STORE,SFLOW
C
C  COMMON/MTL/ APPEARS IN THE FOLLOWING ROUTINES--MAIN,DATAIN,ASEMBL,
C  SPROP
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*4 PMAT,THPAR,AKPAR,SUBHD
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBANC,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
```

```
      COMMON/RFSP/DCYFLX(690 ),HCON(690 ),FLX(690 ),DCOSX(612 ),
     > DCOSZ(612 ),DL(612 ),TRF(2,20),RF(2,20),RFALL(2),IRFTYP(690 ),
     > NPRS(690 ),NPCON(690 ),NPFLX(690 ),NRSE(612 ),IS(612 ,4),NRFPR,
     > NRFPAR,NRSEL,NRSN
      COMMON/MTL/PROP(2,5),THPROP(2,52),AKPROP(2,52),HPROP(2,52),
     > CAPROP(2,52),NSPPM
      DIMENSION R(690 ),RP(690 ),H(690 ),HP(690 ),HT(690 ),HW(690 ),
     > BFLXP(690 ),BFLX(690 ),RSFLX(690 ),NPCNV(690 ),C(690 ,12),
     > TH(612 ,4),DTH(612 ,4),AKX(612 ,4),AKZ(612 ,4),VX(612 ,4),
     > VZ(612 ,4),AKPAR(3,2),KPR(2500),SUBHD(8,3),FRATE(10),FLOW(10),
     > TFLOW(10),TITLE(9),THPAR(3,8),PMAT(3,5)
      DATA MAXNP,MAXEL,MAXMAT,MAXHBP,MXRFPR,MXRPAR,MAXNTI
     > /690,612 ,2,12,2,20,2500/
      DATA NMPPM,NTHPPM,NAKPPM,MXSPPM /5,8,2,52/
      DATA PMAT/4H    ,4H ALP,4H    ,4H    B,4HETAP,4H    ,4H    ,
     > 4H POR,4H    ,4H    ,4H KX ,4H    ,4H    ,4H KZ ,4H    /
      DATA THPAR/4H    ,4H TH1,4H    ,4H    ,4H TH2,4H    ,4H    ,
     > 4H  HO ,4H    ,4H    ,4H  A1,4H    ,4H    ,4H  A2,4H    ,4H
     > 4H  R1,4H    ,4H    ,4H  R2,4H    ,4H    ,4H  C,4H    /
      DATA AKPAR/4H    ,4H  B1,4H    ,4H    ,4H  B2,4H    /
      DATA SUBHD/4HINPU,4HT IN,4HITIA,4HL CO,4HNDIT,4HIONS,2*4H    ,
     > 4HSTEA,4HDY-S,4HTATE,4H INI,4HTIAL,4H CON,4HDITI,4HONS , 8*
     > 4H    /
C
C  PROBLEM  IDENTIFICATION  AND  DESCRIPTION
C
   10 READ 10000,NPROB, (TITLE(I),I=1,9)
      IF (NPROB.LE.0) GO TO 270
      PRINT 10100,NPROB,(TITLE(I),I=1,9)
C
C  READ AND PRINT INPUT DATA
C
      KOUT=0
      KSS=1
      CALL DATAIN(H,RP,MAXEL,MAXNP,MAXMAT,ISTOP,MAXDIF,PMAT,THPAR,
     > AKPAR,NMPPM,NTHPPM,NAKPPM,MXRFPR,MXRPAR,MXSPPM,KSS, TOLA,TOLB,
     > MAXNTI,KPRO,KPR,KSTR,W,TIME,HT,TH,VX,VZ,TITLE,NPROB,MAXIT,MAXCY)
      KDIG=NSTRT
      IF (ISTOP.GT.0) GO TO 270
C
C  COMPUTE BAND-WIDTH VARIABLES
C
      IHALFB=MAXDIF
      IBAND=2*IHALFB+1
      IHBP=IHALFB+1
      IF (IHBP.GT.MAXHBP) GO TO 260
C
C  PREPARE INITIAL VARIABLES
C
      CALL SPROP(TH,DTH,AKX,AKZ,H,MAXEL,MAXNP)
      KFLOW=-1
      CALL SFLOW(VX,VZ,TH,BFLX,BFLXP,FRATE,FLOW,MAXEL,MAXNP,TFLOW,KFLOW,
     >  H,AKX,AKZ)
      CALL VELT(VX,VZ,HT,H,AKX,AKZ,MAXEL,MAXNP)
C
C  PRINT INITIAL VARIABLES
C
      KDIAG=0
      CALL PRINTT(NNP,IBAND,MAXNP,MAXEL,DELT,H,HT,VX,VZ,TH, AKX,AKZ,DTH,
     >  TIME,IE,NEL,KPRO,SUBHD(1,1),KCUT, BFLX,FRATE,FLOW,NRSN,NPCON,
```

```
     > NPFLX,IFLOW,KDIAG,NPRS,RSFLX)
      IF (KSTR.EQ.1.AND.KSS.EQ.1.AND.NSTRT.EQ.0) CALL STORE(NPROB,MAXNP,
     >  MAXEL,H,HT,VX,VZ,TH,TIME,TITLE)
      IF (KSS.NE.0) GO TO 130
C
C  PERFORM STEADY-STATE CALCULATION
C
      IF (NRSN.EQ.0) GO TO 30
      DO 20 NPP=1,NRSN
         NPCON(NPP)=NPRS(NPP)
   20    NPFLX(NPP)=0
      NCHG=-1
      CALL BCPREP(NCHG,MAXNP,TIME,VX,VZ,MAXEL,MXRFPR,H,AKX,AKZ)
   30 DO 40 NP=1,NNP
   40    HP(NP)=H(NP)
      NIT=0
      KDIG=KDIG+1
      PRINT 10400,KDIG,TIME,DELT
      DO 100 ICY=1,MAXCY
         DO 50 NP=1,NNP
   50       H(NP)=HP(NP)
         DO 80 IT=1,MAXIT
            NIT=NIT+1
C
C  EVALUATE SOIL PROPERTIES FOR PREVIOUS ITERATE
C
            CALL SPROP(TH,DTH,AKX,AKZ,H,MAXEL,MAXNP)
C
C  ASSEMBLE STEADY-STATE COEFFICIENT MATRICES A, B, AND C, AND CONSTRUCT
C  LOAD VECTOR R
C
            CALL ASEMBL(C,R,RP,H,HP,TH,DTH,AKX,AKZ,MAXNP, MAXHBP,MAXEL,
     >       KSS,W)
C
C  APPLY STEADY-STATE BOUNDARY CONDITIONS
C
            CALL BC(C,R,RP,MAXNP,MAXHBP,KSS)
C
C  TRIANGULARIZE STEADY-STATE C MATRIX
C
            CALL BANSOL(1,C,R,NNP,IHBP,MAXNP,MAXHBP)
C
C  BACK-SUBSTITUTE FOR STEADY-STATE SOLUTION
C
            CALL BANSOL(2,C,R,NNP,IHBP,MAXNP,MAXHBP)
C
C  OBTAIN MAXIMUM RELATIVE DEVIATION FROM PREVIOUS ITERATE
C
            NPP=0
            RD=-1.
            RES=-1.
            DO 60 NP=1,NNP
               RESNP=DABS(R(NP)-H(NP))
               RES=DMAX1(RES,RESNP)
               IF (H(NP).NE.0.D0) RD=DMAX1(RD,DABS(RESNP/H(NP)))
               IF (RESNP.LE.TOLA) GO TO 60
               NPP=NPP+1
               NPCNV(NPP)=NP
   60          CONTINUE
            NNCVN=NPP
```

```
C
C  UPDATE PRESSURE WITH CURRENT ITERATE
C
            DO 70 NP=1,NNP
   70          H(NP)=R(NP)
C
C  ESCAPE FROM ITERATION LOOP IF THE MAXIMUM RESIDUAL IS
C  SUFFICIENTLY SMALL
C
            PRINT 10200,NIT,RES,RD,NNCVN
            IF (IT.EQ.1) GO TO 80
            IF (RES.LT.TOLA) GO TO 90
   80       CONTINUE
C
C  PRINT NONCONVERGING NODES
C
        PRINT 10500
        PRINT 10600,(NPCNV(NPP),NPP=1,NNCVN)
C
C  CALCULATE FLOW RATES
C
   90   CALL SPROP(TH,DTH,AKX,AKZ,H,MAXEL,MAXNP)
        IF (NRSN.EQ.0) GO TO 110
        CALL BCPREP(NCHG,MAXNP,TIME,VX,VZ,MAXEL,MXRFPR,H,AKX,AKZ)
        IF (NCHG.EQ.0) GO TO 110
  100   CONTINUE
  110 KFLOW=-1
      CALL SFLOW(VX,VZ,TH,BFLX,BFLXP,FRATE,FLOW,MAXEL,MAXNP,TFLOW,KFLOW,
     >  H,AKX,AKZ)
      CALL VELT(VX,VZ,HT,H,AKX,AKZ,MAXEL,MAXNP)
      DO 120 I=1,6
         FLOW(I)=0.
  120    TFLOW(I)=0.
      FRATE(7)=0.
      FLOW(7)=0.
C
C  PRINT STEADY-STATE VARIABLES
C
      CALL PRINTT(NNP,IBAND,MAXNP,MAXEL,DELT,H,HT,VX,VZ,TH, AKX,AKZ,DTH,
     >  TIME,IE,NEL,KPRO,SUBHD(1,2),KOUT, BFLX,FRATE,FLOW,NRSN,NPCON,
     > NPFLX,TFLOW,KDIAG,NPRS,RSFLX)
      IF (KSTR.EQ.1) CALL STORE(NPROB,MAXNP,MAXEL,H,HT,VX,VZ,TH,TIME,
     > TITLE)
      IF (NTI.EQ.0) GO TO 10
C
C  READ TRANSIENT BOUNDARY CONDITIONS
C
      CALL DATAIN(H,RP,MAXEL,MAXNP,MAXMAT,ISTOP,MAXDIF,PMAT,THPAR,
     > AKPAR,NMPPM,NTHPPM,NAKPPM,MXRFPR,MXRPAR,MXSPPM,KSS, TOLA,TOLB,
     > MAXNTI,KPRO,KPR,KSTR,W,TIME,HT,TH,VX,VZ,TITLE,NPROB,MAXIT,MAXCY)
      KSS=1
C
C  PERFORM TRANSIENT-STATE CALCULATION
C
  130 IF (NRSN.EQ.0) GO TO 160
      IF (NSTRT.GT.0) GO TO 150
      DO 140 NPP=1,NRSN
         NPCON(NPP)=NPRS(NPP)
  140    NPFLX(NPP)=0
  150 NCHG=-1
```

```
      CALL BCPREP(NCHG,MAXNP,TIME,VX,VZ,MAXEL,MXRFPR,H,AKX,AKZ)
  160 TIME=TIME+DELT
      W1=W
      W2=1.-W
      KFLOW=1
      DO 250 ITM=1,NTI
         DO 170 NP=1,NNP
  170       HP(NP)=H(NP)
         NIT=0
         KDIG=KDIG+1
         PRINT 10400,KDIG,TIME,DELT
         DO 230 ICY=1,MAXCY
            DO 180 NP=1,NNP
  180          HW(NP)=HP(NP)
            DO 210 IT=1,MAXIT
               NIT=NIT+1
C
C  EVALUATE SOIL PROPERTIES FOR PREVIOUS ITERATE
C
               CALL SPROP(TH,DTH,AKX,AKZ,HW,MAXEL,MAXNP)
C
C  ASSEMBLE COEFFICIENT MATRICES A, B, AND C, AND CONSTRUCT LOAD
C  VECTOR R
C
               CALL ASEMBL(C,R,RP,H,HP,TH,DTH,AKX,AKZ,MAXNP, MAXHBP,
     >          MAXEL,KSS,W)
C
C  APPLY BOUNDARY CONDITIONS
C
               CALL BC(C,R,RP,MAXNP,MAXHBP,KSS)
C
C  TRIANGULARIZE C MATRIX
C
               CALL BANSOL(1,C,R,NNP,IHBP,MAXNP,MAXHBP)
C
C  BACK-SUBSTITUTE
C
               CALL BANSOL(2,C,R,NNP,IHBP,MAXNP,MAXHBP)
C
C  OBTAIN MAXIMUM RELATIVE DEVIATION FROM PREVIOUS ITERATE
C
               NPP=0
               RD=-1.
               RES=-1.
               DO 190 NP=1,NNP
                  RESNP=DABS(R(NP)-H(NP))
                  RES=DMAX1(RES,RESNP)
                  IF (H(NP).NE.0.D0) RD=DMAX1(RD,DABS(RESNP/H(NP)))
                  IF (RESNP.LE.TCLB) GO TO 190
                  NPP=NPP+1
                  NPCNV(NPP)=NP
  190             CONTINUE
               NNCVN=NPP
C
C  UPDATE PRESSURE WITH CURRENT ITERATE
C
               DO 200 NP=1,NNP
                  H(NP)=R(NP)
  200             HW(NP)=W1*H(NP)+W2*HP(NP)
C
```

```
C  ESCAPE FROM ITERATION LOOP IF THE MAXIMUM RESIDUAL IS
C  SUFFICIENTLY SMALL
C
               PRINT 10200,NIT,RES,RD,NNCVN
               IF (IT.EQ.1.AND.ITM.EQ.1) GO TO 210
               IF (RES.LT.TOLB) GO TO 220
  210          CONTINUE
C
C  PRINT NONCONVERGING NODES
C
            PRINT 10500
            PRINT 10600,(NPCNV(NPP),NPP=1,NNCVN)
C
C  CALCULATE FLOW RATES
C
  220       CALL SPROP(TH,DTH,AKX,AKZ,H,MAXEL,MAXNP)
            IF (NRSN.EQ.0) GO TO 240
            CALL BCPREP(NCHG,MAXNP,TIME,VX,VZ,MAXEL,MXRFPR,H,AKX,AKZ)
            IF (NCHG.EQ.0) GO TO 240
  230       CONTINUE
  240    CALL SFLOW(VX,VZ,TH,BFLX,BFLXP,FRATE,FLOW,MAXEL,MAXNP,TFLOW,
     >    KFLOW,H,AKX,AKZ)
         CALL VELT(VX,VZ,HT,H,AKX,AKZ,MAXEL,MAXNP)
C
C  PRINT VARIABLES AT EACH TIME STEP
C
         CALL PRINTT(NNP,IBAND,MAXNP,MAXEL,DELT,H,HT,VX,VZ,TH, AKX,AKZ,
     >    DTH,TIME,IE,NEL,KPR(ITM),SUBHD(1,3),KOUT, BFLX,FRATE,FLOW,
     >    NRSN,NPCON,NPFLX,TFLOW,KDIAG,NPRS,RSFLX)
         IF (KSTR.EQ.1) CALL STORE(NPROB,MAXNP,MAXEL,H,HT,VX,VZ,TH,TIME,
     >     TITLE)
C
C  PREPARE FOR NEXT TIME STEP
C
         IF (TIME.GT.TMAX) GO TO 10
         DELT=DELT*(1.+CHNG)
         DELT=DMIN1(DELT,DELMAX)
         TIME=TIME+DELT
  250    CONTINUE
      GO TO 10
  260 PRINT 10300,IHBP,MAXHBP
  270 STOP
10000 FORMAT(I5,9A8)
10100 FORMAT(/8H1PROBLEM,I5,3H.. ,9A8/)
10200 FORMAT(5X,I10,3X,E12.4,3X,E12.4,15X,I10)
10300 FORMAT(///26H HALF-BANDWIDTH-PLUS-ONE =,I4,
     > 25H EXCEEDS MAX. ALLOWABLE =,I4)
10400 FORMAT(///53H *****************************************************
     > 62H**************************************************************
     > 5H*****///17H DIAGNOSTIC TABLE,I4,12H.. AT TIME =,1PD12.4,
     > 9H ,(DELT = 1PD12.4,1H)///30H TABLE OF ITERATIVE PARAMETERS// 6X,
     > 9HITERATION,7X,8HRESIDUAL,6X,9HDEVIATION,6X,
     > 19HNO. NON-CONV. NODES)
10500 FORMAT(//30H TABLE OF NON-CONVERGING NODES)
10600 FORMAT(/(5X,20I5))
      END
```

```
      SUBROUTINE DATAIN(H,RP,MAXEL,MAXNP,MAXMAT,ISTOP,MAXCIF, PMAT,
     > THPAR,AKPAR,NMPPM,NTHPPM,NAKPPM,MXRFPR,MXRPAR,MXSPPM,KSS, TOLA,
     > TOLB,MAXNTI,KPRO,KPR,KSTR,W,TIME,HT,TH,VX,VZ,TITLE,NPROB,MAXIT,
     > MAXCY)
C
C
C  FUNCTION OF SUBROUTINE--TO READ, PRINT, AND CHECK VARIABLES
C  PERTAINING TO SIMULATION TIME, GEOMETRY OF THE SYSTEM, ITS SOIL
C  PROPERTIES, BOUNDARY-INITIAL CONDITIONS FOR BOTH STEADY-STATE AND
C  TRANSIENT CASES, AND NUMERICAL CONVERGENCE CRITERIA.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*4 PMAT,PMAT,THPAR,AKPAR
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/RFSP/DCYFLX(690 ),HCON(690 ),FLX(690 ),DCOSX(612 ),
     > DCOSZ(612 ),DL(612 ),TRF(2,20),RF(2,20),RFALL(2),IRFTYP(690 ),
     > NPRS(690 ),NPCON(690 ),NPFLX(690 ),NRSE(612 ),IS(612 ,4),NRFPR,
     > NRFPAR,NRSEL,NRSN
      COMMON/MTL/PROP(2,5),THPROP(2,52),AKPROP(2,52),HPROP(2,52),
     > CAPROP(2,52),NSPPM
      DIMENSION PMAT(3,NMPPM),THPAR(3,NTHPPM), AKPAR(3,NAKPPM),RP(MAXNP)
     >  ,H(MAXNP),KPR(MAXNTI),HT(MAXNP),TH(MAXEL,4),VX(MAXEL,4),
     > VZ(MAXEL,4),TITLE(9)
      IF (KSS.EQ.0) GO TO 1040
      ISTOP=0
      READ 12000,NNP,NEL,NMAT,NCM,NTI,KSS,KSP,NSPPM,KSTR,KCP,KGRAV,
     > NSTRT,MAXIT,MAXCY
      IF (KSS.NE.0) KSS=1
      IF (KSP.NE.0) KSP=1
      IF (KSTR.NE.0) KSTR=1
      IF (KCP.NE.0) KCP=1
      IF (KGRAV.NE.0) KGRAV=1
      IF (MAXIT.LE.0) MAXIT=10
      IF (MAXCY.LE.0) MAXCY=3
      READ 12300, DELT,CHNG,DELMAX,TMAX,FE,TOLA,TOLB,RHO,GRAV,VISC,W
      IF (DELMAX.LE.0.D0) DELMAX=1.E50
      IF (TMAX.LE.0.D0) TMAX=1.E50
      PRINT 10000,NNP,NEL,NMAT,NCM,NTI,KSS,KSP,NSPPM,KSTR,KCP,KGRAV,
     > NSTRT,MAXIT,MAXCY
      PRINT 10100,DELT,CHNG,DELMAX,TMAX,FE,TOLA,TOLB,RHO,GRAV,VISC,W
      READ 12100,KPRO,(KPR(ITM),ITM=1,NTI)
      PRINT 10200
      PRINT 12200,KPRO,(KPR(ITM),ITM=1,NTI)
      PI=3.14159265
      FE=FE*PI/180.
      SNFE=DSIN(FE)
      CSFE=DCOS(FE)
      IF (KGRAV.EQ.1) SNFE=0.
      IF (KGRAV.EQ.1) CSFE=0.
C
C  CHECK TO BE SURE INPUT DATA DO NOT EXCEED STORAGE CAPACITY
C
      IF (NNP.GE.0.AND.NNP.LE.MAXNP) GO TO 10
      ISTOP=ISTOP+1
      PRINT 13700, MAXNP
```

```
   10 IF (NEL.GE.0.AND.NEL.LE.MAXEL) GO TO 20
      ISTOP=ISTOP+1
      PRINT 13800, MAXEL
   20 IF (NMAT.GE.0.AND.NMAT.LE.MAXMAT) GO TO 30
      ISTOP=ISTOP+1
      PRINT 13900, MAXMAT
   30 IF (NCM.GE.0.AND.NCM.LE.MAXEL) GO TO 40
      ISTOP=ISTOP+1
      PRINT 14100,MAXEL
   40 IF (NSPPM.GE.0.AND.NSPPM.LE.MXSPPM) GO TO 50
      ISTOP=ISTOP+1
      PRINT 14000,MXSPPM
   50 IF (NTI.GE.0.AND.NTI.LE.MAXNTI) GO TO 60
      ISTOP=ISTOP+1
      PRINT 14200,MAXNTI
   60 IF (ISTOP.EQ.0) GO TO 70
      PRINT 15000, ISTOP
      STOP
C
C  READ AND PRINT MATERIAL PROPERTIES
C
   70 IF (NMPPM.LE.0) GO TO 90
      IF (NMAT.LE.0) GO TO 90
      PRINT 10300,((PMAT(I,J),I=1,3),J=1,NMPPM)
      DO 80 I=1,NMAT
         READ 12300,(PROP(I,J),J=1,NMPPM)
   80    PRINT 12500,I,(PROP(I,J),J=1,NMPPM)
   90 IF (KSP.EQ.1) GO TO 120
C
C  SOIL PROPERTIES ARE TO BE REPRESENTED BY ANALYTIC FUNCTIONS
C
C
C  READ AND PRINT MOISTURE-CONTENT PARAMETERS
C
      IF (NSPPM.EQ.0) GO TO 200
      PRINT 10500,((THPAR(I,J),I=1,3),J=1,NSPPM)
      DO 100 I=1,NMAT
         READ 12300, (THPROP(I,J),J=1,NSPPM)
         PRINT 12700, I,(THPROP(I,J),J=1,NSPPM)
  100    CONTINUE
C
C  READ AND PRINT CONDUCTIVITY PARAMETERS
C
      PRINT 10600,((AKPAR(I,J),I=1,3),J=1,NSPPM)
      DO 110 I=1,NMAT
         READ 12300, (AKPROP(I,J),J=1,NSPPM)
         PRINT 12700, I,(AKPROP(I,J),J=1,NSPPM)
  110    CONTINUE
      GO TO 200
  120 IF (NSPPM.EQ.0) GO TO 200
C
C  SOIL PROPERTIES ARE TO BE GIVEN IN TABULAR FORM
C
C
C  READ PRESSURES
C
      DO 130 I=1,NMAT
         READ 12300, (HPROP(I,J),J=1,NSPPM)
  130    CONTINUE
C
```

```
C  READ WATER CONTENTS
C
      DO 140 I=1,NMAT
         READ 12300, (THPROP(I,J),J=1,NSPPM)
  140    CONTINUE
C
C  READ CONDUCTIVITIES OR PERMEABILITIES
C
      DO 150 I=1,NMAT
         READ 12300, (AKPROP(I,J),J=1,NSPPM)
  150    CONTINUE
C
C  READ WATER CAPACITIES
C
      DO 160 I=1,NMAT
         READ 12300, (CAPROP(I,J),J=1,NSPPM)
  160    CONTINUE
      PRINT 10400
      DO 170 I=1,NMAT
         PRINT 12600,I,(HPROP(I,J),THPROP(I,J),AKPROP(I,J),CAPROP(I,J),
     >    J=1,NSPPM)
  170    CONTINUE
      IF (KCP.EQ.0) GO TO 200
C
C  CONVERT FROM PERMEABILITY TO CONDUCTIVITY IF NECESSARY
C
      DO 190 I=1,NMAT
         PKCF=RHO*GRAV/VISC
         PROP(I,4)=PROP(I,4)*PKCF
         PROP(I,5)=PROP(I,5)*PKCF
         DO 180 J=1,NSPPM
  180       AKPROP(I,J)=AKPROP(I,J)*PKCF
  190    CONTINUE
C
C  READ AND PRINT NODAL-POINT DATA
C
  200 PRINT 10700
      NI=1
  210 READ 12800, NJ,X(NJ),Z(NJ)
      IF (NJ-NI) 220,250,230
  220 PRINT 15100, NJ
      PRINT 12900, NJ,X(NJ),Z(NJ)
      ISTOP=ISTOP+1
      GO TO 210
  230 DF=NJ+1-NI
      DX=(X(NJ)-X(NI-1))/DF
      DZ=(Z(NJ)-Z(NI-1))/DF
  240 CONTINUE
      X(NI)=X(NI-1)+DX
      Z(NI)=Z(NI-1)+DZ
  250 PRINT 12900,NI,X(NI),Z(NI)
      NI=NI+1
      IF (NJ-NI) 260,250,240
  260 IF (NI.LE.NNP) GO TO 210
C
C  READ AND PRINT ELEMENT DATA
C
C  ALSO COMPUTE MAXIMUM NODAL DIFFERENCE FOR EACH ELEMENT
C
      PRINT 10800
```

```
      MAXDIF = 0
      MJ = 0
  270 READ 12000, MI,(IE(MI,I),I=1,5),MODL,NLAY
      MTYP=IE(MI,5)
      MND = 0
      DO 280 IQ=1,3
         IQ1 = IQ + 1
         DO 280 JQ=IQ1,4
            ND = IABS(IE(MI,IQ)-IE(MI,JQ))
            MND = MAXO(ND,MND)
  280       MAXDIF = MAXO(ND,MAXDIF)
  290 MJ = MJ + 1
      IF (MI-MJ) 300,330,310
  300 PRINT 15200, MI
      PRINT 13000, MI,(IE(MI,I),I=1,5),MND
      ISTOP = ISTOP + 1
  310 DO 320 IQ=1,4
  320    IE(MJ,IQ) = IE(MJ-1,IQ) + 1
      IE(MJ,5) = IE(MJ-1,5)
  330 PRINT 13000, MJ,(IE(MJ,I),I=1,5),MND
      IF (MJ.LT.MI) GO TO 290
      IF (MJ.EQ.NEL) GO TO 370
      IF (MODL.LE.0) GO TO 270
      DO 360 I=1,NLAY
         LL=2
         DO 360 J=1,MODL
            IF (MJ.EQ.MI) GO TO 350
            DO 340 KQ=1,4
  340          IE(MJ,KQ) = IE(MJ-1,KQ) + LL
            IE(MJ,5)=IE(MJ-1,5)
            PRINT 13000, MJ,(IE(MJ,K),K=1,5),MND
  350       LL = 1
  360       MJ = MJ + 1
      MJ = MJ - 1
      IF (MJ.LT.NEL) GO TO 270
  370 CONTINUE
C
C  MODIFY MATERIAL TYPES FOR SELECTED ELEMENTS IF NECESSARY
C
      IF (NCM.LE.0) GO TO 410
      PRINT 10900
      L=0
  380 READ 12000, MI,MTYP,MK,MINC
      IE(MI,5) = MTYP
      PRINT 13100, MI,IE(MI,5)
      L = L + 1
      IF (MK.LE.MI) GO TO 400
      IF (MINC.LE.0) MINC = 1
      MI = MI + MINC
      DO 390 MJ=MI,MK,MINC
         IE(MJ,5) = MTYP
         PRINT 13100, MJ,IE(MJ,5)
  390    L = L + 1
  400 IF (L.LT.NCM) GO TO 380
  410 CONTINUE
      DO 420 M=1,NEL
         MTYP=IE(M,5)
         IF (MTYP.GT.0.AND.MTYP.LE.NMAT) GO TO 420
         PRINT 15900,M
         ISTOP=ISTOP+1
```

```
  420    CONTINUE                                                       DATA1195
      IF (ISTOP.EQ.0) GO TO 430                                         DATA1200
      PRINT 15000, ISTOP                                                DATA1205
      STOP                                                              DATA1210
C                                                                       DATA1215
C  READ INITIAL CONDITIONS                                              DATA1220
C                                                                       DATA1225
  430 TIME=0.                                                           DATA1230
      IF (NSTRT.EQ.0) GO TO 450                                         DATA1235
      REWIND 1                                                          DATA1240
      REWIND 2                                                          DATA1245
      READ(2) (DUM,I=1,9),IDUM,NPT,NET,IDUM,NRST                        DATA1250
      IF (KSTR.EQ.1) WRITE(1) (TITLE(I),I=1,9),NPRCB,NNP,NEL,NTI,MAXNP  DATA1255
      READ(2) (X(NP),NP=1,NPT),(Z(NP),NP=1,NPT),((IE(M,IQ),M=1,NET),IQ= DATA1260
     > 1,4)                                                             DATA1265
      IF (KSTR.EQ.1) WRITE(1) (X(NP),NP=1,NNP),(Z(NP),NP=1,NNP), ((IE(M,DATA1270
     > IQ),M=1,NEL),IQ=1,4)                                             DATA1275
      DO 440 ITM=1,NSTRT                                                DATA1280
         READ(2) TIME,(H(NP),NP=1,NPT),(HT(NP),NP=1,NPT),((TH(M,IQ),M=1,DATA1285
     >      NET),IQ=1,4),((VX(M,IC),M=1,NET),IQ=1,4),((VZ(M,IQ),M=1,NET),DATA1290
     >      IQ=1,4),(NPCON(NP),NP=1,NRST),(NPFLX(NP),NP=1,NRST)         DATA1295
         IF (KSTR.EQ.0) GO TO 440                                       DATA1300
         WRITE(1) TIME,(H(NP),NP=1,NNP),(HT(NP),NP=1,NNP),((TH(M,IQ),M= DATA1305
     >      1 ,NEL),IQ=1,4),((VX(M,IQ),M=1,NEL),IQ=1,4),((VZ(M,IQ),M=1, DATA1310
     >     NEL), IQ=1,4),(NPCON(NP),NP=1,MAXNP),(NPFLX(NP),NP=1,MAXNP)  DATA1315
  440    CONTINUE                                                       DATA1320
      GO TO 500                                                         DATA1325
  450 NI = 0                                                            DATA1330
      NJ = 0                                                            DATA1335
  460 IF (NJ.EQ.NNP) GO TO 500                                          DATA1340
      READ 13600,NJ,H(NJ)                                               DATA1345
  470 NI = NI + 1                                                       DATA1350
      IF (NI.GT.1) GO TO 480                                            DATA1355
      IF (NJ.EQ.1) GO TO 480                                            DATA1360
      PRINT 15300,NJ                                                    DATA1365
      ISTOP=ISTOP+1                                                     DATA1370
      GO TO 500                                                         DATA1375
  480 IF (NJ.EQ.NI) GO TO 460                                           DATA1380
      IF (NJ.GT.NI) GO TO 490                                           DATA1385
      PRINT 15300,NJ                                                    DATA1390
      ISTOP=ISTOP+1                                                     DATA1395
      GO TO 500                                                         DATA1400
  490 H(NI)=H(NI-1)                                                     DATA1405
      GO TO 470                                                         DATA1410
C                                                                       DATA1415
C  IDENTIFY BOUNDARY ELEMENTS AND COMPUTE DIRECTION COSINES OF          DATA1420
C  BOUNDARY SIDES                                                       DATA1425
C                                                                       DATA1430
  500 CALL SURF                                                         DATA1435
      IF (KSS.EQ.1) GO TO 1040                                          DATA1440
      NRSN=0                                                            DATA1445
C                                                                       DATA1450
C  READ STEADY-STATE PARAMETERS                                         DATA1455
C                                                                       DATA1460
      READ 12000,NBC,NST,NRFPR,NRFPAR,NRSEL,NRSN                        DATA1465
      PRINT 11000,NBC,NST,NRFPR,NRFPAR,NRSEL,NRSN                       DATA1470
      IF (NBC.GE.0.AND.NBC.LE.MAXNP) GO TO 510                          DATA1475
      ISTOP=ISTOP+1                                                     DATA1480
      PRINT 14300,MAXNP                                                 DATA1485
  510 IF (NST.GE.0.AND.NST.LE.MAXNP) GO TO 520                          DATA1490
```

```
      ISTOP=ISTOP+1
      PRINT 14400,MAXNP
  520 IF (NRFPR.GE.0.AND.NRFPR.LE.MXRFPR) GO TO 530
      ISTOP=ISTOP+1
      PRINT 14500,MXRFPR
  530 IF (NRFPAR.GE.0.AND.NRFPAR.LE.MXRPAR) GO TO 540
      ISTOP=ISTOP+1
      PRINT 14600,MXRPAR
  540 IF (NRSEL.GE.0.AND.NRSEL.LE.MAXEL) GO TO 550
      ISTOP=ISTOP+1
      PRINT 14700,MAXEL
  550 IF (NRSN.GE.0.AND.NRSN.LE.MAXNP) GO TO 560
      ISTOP=ISTOP+1
      PRINT 14800,MAXNP
  560 IF (ISTOP.EQ.0) GO TO 570
      PRINT 15000, ISTOP
      STOP
C
C  READ AND PRINT STEADY-STATE RAINFALL-SEEPAGE INFORMATION
C
  570 IF (NRSN.EQ.0) GO TO 800
C
C  STEADY-STATE RAINFALL PROFILES
C
      IF (NRFPR.EQ.0) GO TO 590
      PRINT 11400
      DO 580 I=1,NRFPR
         READ 12300,(TRF(I,J),J=1,NRFPAR)
         READ 12300,(RF(I,J),J=1,NRFPAR)
         PRINT 11500,I
         DO 580 J=1,NRFPAR
  580       PRINT 12400,(TRF(I,J),RF(I,J))
C
C  STEADY-STATE RAINFALL TYPES AND PONDING DEPTHS
C
  590 DO 600 NP=1,NNP
  600    IRFTYP(NP)=0
      NPP=0
  610 IF (NPP.EQ.NRSN) GO TO 670
      IF (NPP.LT.NRSN) GO TO 620
      PRINT 14800,NRSN
      ISTOP=ISTOP+1
      GO TO 670
  620 READ 13400,NI,ITYP,NPINC,HCONI
      IF (NPINC.GT.0) GO TO 640
  630 NPP=NPP+1
      NPRS(NPP)=NI
      IRFTYP(NI)=ITYP
      HCON(NI)=HCONI
      GO TO 610
  640 IF (NPP.GT.0) GO TO 650
      ISTOP=ISTOP+1
      PRINT 15500
  650 NJ=NPRS(NPP)
      JTYP=IRFTYP(NJ)
      HCONJ=HCON(NJ)
      NJ=NJ+NPINC
      NK=NI-1
      DO 660 NP=NJ,NK,NPINC
         NPP=NPP+1
```

```
         NPRS(NPP)=NP
         IRFTYP(NP)=JTYP
  660    HCON(NP)=HCONJ
      GO TO 630
  670 PRINT 11600
      DO 680 NPP=1,NRSN
         NP=NPRS(NPP)
  680    PRINT 13500,NP,IRFTYP(NP),HCON(NP)
C
C  STEADY-STATE RAINFALL-SEEPAGE ELEMENT SURFACE INFORMATION
C
      MPI=0
  690 IF (MPI.EQ.NRSEL) GO TO 740
      READ 12000,MI,IS1,IS2,KINC
      IF (KINC.GT.0) GO TO 710
  700 MPI=MPI+1
      NRSE(MPI)=MI
      IS(MPI,1)=IS1
      IS(MPI,2)=IS2
      GO TO 690
  710 IF (MPI.GT.0) GO TO 720
      ISTOP=ISTOP+1
      PRINT 15600
  720 NPINC=IS(MPI,2)-IS(MPI,1)
      MINC=IABS(NPINC)-1
      MINC=MAX0(MINC,1)
      MJ=NRSE(MPI)+MINC
      MK=MI-1
      DO 730 M=MJ,MK,MINC
         MPJ=MPI
         MPI=MPI+1
         NRSE(MPI)=M
         IS(MPI,1)=IS(MPJ,1)+NPINC
  730    IS(MPI,2)=IS(MPJ,2)+NPINC
      GO TO 700
  740 PRINT 11700
      DO 750 MP=1,NRSEL
         M=NRSE(MP)
  750    PRINT 13000,M,IS(MP,1),IS(MP,2)
C
C  DETERMINE DIRECTION COSINES FOR STEADY-STATE RAINFALL-SEEPAGE
C  SURFACES
C
      DO 790 MPI=1,NRSEL
         MI=NRSE(MPI)
         DO 780 MPJ=1,NBEL
            MJ=NBE(MPJ)
            IF (MJ.NE.MI) GO TO 780
            IF (ISB(MPJ,1).EQ.IS(MPI,1).AND.ISB(MPJ,2).EQ.IS(MPI,2)) GO
     >         TO 760
            IF (ISB(MPJ,1).EQ.IS(MPI,2).AND.ISB(MPJ,2).EQ.IS(MPI,1)) GO
     >         TO 760
            GO TO 780
  760       DO 770 J=1,4
  770          IS(MPI,J)=ISB(MPJ,J)
            DL(MPI)=DLB(MPJ)
            DCOSX(MPI)=DCOSXB(MPJ)
            DCOSZ(MPI)=DCOSZB(MPJ)
            GO TO 790
  780       CONTINUE
```

```
         ISTOP=ISTOP+1
         PRINT 14900,MI
  790    CCNTINUE
  800 DO 810 NP=1,NNP
  810    RP(NP)=0.
      IF (NBC.EQ.0) GO TO 900
C
C  READ STEADY-STATE BOUNDARY CCNDITICNS OF THE FORM H=BB
C
      NPP=0
  820 IF (NPP.EQ.NBC) GO TO 880
      IF (NPP.LT.NBC) GO TO 830
      PRINT 14300,NBC
      ISTOP=ISTOP+1
      GO TO 880
  830 READ 13300,NI,NPINC,BBI
      IF (NPINC.GT.0) GO TO 850
  840 NPP=NPP+1
      NN(NPP)=NI
      BB(NPP)=BBI
      GO TO 820
  850 IF (NPP.GT.0) GO TO 860
      ISTOP=ISTOP+1
      PRINT 15400
  860 NJ=NN(NPP)+NPINC
      BBJ=BB(NPP)
      NK=NI-1
      DO 870 NP=NJ,NK,NPINC
         NPP=NPP+1
         NN(NPP)=NP
  870    BB(NPP)=BBJ
      GO TO 840
  880 PRINT 11100
      DO 890 NPP=1,NBC
  890    PRINT 13200,NN(NPP),BB(NPP)
  900 IF (NST.LE.0) GO TO 1000
C
C  READ STEADY-STATE SURFACE-TERM POINT FLUXES
C
      NPP=0
      MP=0
      PRINT 11200
  910 IF (MP.EQ.NST) GO TO 960
      READ 13400,NI,NJ,KINC,EI,EJ
      IF (KINC.GT.0) GO TO 930
  920 MP=MP+1
      DX=X(NI)-X(NJ)
      DZ=Z(NI)-Z(NJ)
      EL=DSQRT(DX*DX+DZ*DZ)
      PRINT 13500,NI,NJ,EI,EJ
      RP(NI)=RP(NI)+EI*EL/3.0+EJ*EL/6.0
      RP(NJ)=RP(NJ)+EI*EL/6.0+EJ*EL/3.0
      NPP=NPP+1
      NPST(NPP)=NI
      NPP=NPP+1
      NPST(NPP)=NJ
      EK=EJ
      GO TO 910
  930 IF (MP.GT.0) GO TO 940
      ISTOP=ISTOP+1
```

```
      PRINT 15700
  940 NPINC=IABS(NJ-NI)
      NPMIN=MAX0(NPST(NPP),NPST(NPP-1))
      NPMAX=MIN0(NI,NJ)-1
      DO 950 NK=NPMIN,NPMAX,NPINC
         NL=NK+NPINC
         MP=MP+1
         DX=X(NK)-X(NL)
         DZ=Z(NK)-Z(NL)
         EL=DSQRT(DX*DX+DZ*DZ)
         PRINT 13500,NK,NL,EK,EK
         RP(NK)=RP(NK)+EK*EL/2.0
         RP(NL)=RP(NL)+EK*EL/2.0
         NPP=NPP+1
         NPST(NPP)=NK
         NPP=NPP+1
         NPST(NPP)=NL
  950    CONTINUE
      GO TO 920
  960 NPPMAX=NPP
      NSTN=0
      DO 990 NPPI=1,NPPMAX
         IF (NSTN.EQ.0) GO TO 980
         DO 970 NPPJ=1,NSTN
            IF (NPST(NPPI).EQ.NPST(NPPJ)) GO TO 990
  970       CONTINUE
  980    NSTN=NSTN+1
         NPST(NSTN)=NPST(NPPI)
  990    CONTINUE
C
C  APPLY STEADY-STATE DIRICHLET BOUNDARY CONDITIONS TO INITIAL
C  CONDITIONS
C
 1000 IF (NBC.EQ.0) GO TO 1020
      DO 1010 NPP=1,NBC
         NP=NN(NPP)
 1010    H(NP)=BB(NPP)
 1020 IF (ISTOP.EQ.0) GO TO 1030
      PRINT 15800, ISTOP
 1030 RETURN
C
C  READ TRANSIENT-STATE PARAMETERS
C
 1040 READ 12000,NBC,NST,NRFPR,NRFPAR,NRSEL,NRSN
      PRINT 11300,NBC,NST,NRFPR,NRFPAR,NRSEL,NRSN
      IF (NBC.GE.0.AND.NBC.LE.MAXNP) GO TO 1050
      ISTOP=ISTOP+1
      PRINT 14300,MAXNP
 1050 IF (NST.GE.0.AND.NST.LE.MAXNP) GO TO 1060
      ISTOP=ISTOP+1
      PRINT 14400,MAXNP
 1060 IF (NRFPR.GE.0.AND.NRFPR.LE.MXRFPR) GO TO 1070
      ISTOP=ISTOP+1
      PRINT 14500,MXRFPR
 1070 IF (NRFPAR.GE.0.AND.NRFPAR.LE.MXRPAR) GO TO 1080
      ISTOP=ISTOP+1
      PRINT 14600,MXRPAR
 1080 IF (NRSEL.GE.0.AND.NRSEL.LE.MAXEL) GO TO 1090
      ISTOP=ISTOP+1
      PRINT 14700,MAXEL
```

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 1090 IF (NRSN.GE.0.AND.NRSN.LE.MAXNP) GO TO 1100                   DATA2695
      ISTOP=ISTOP+1                                                 DATA2700
      PRINT 14800,MAXNP                                             DATA2705
 1100 IF (ISTOP.EQ.0) GO TO 1110                                    DATA2710
      PRINT 15000, ISTOP                                            DATA2715
      STOP                                                          DATA2720
C                                                                   DATA2725
C  READ AND PRINT TRANSIENT-STATE RAINFALL-SEEPAGE INFORMATION      DATA2730
C                                                                   DATA2735
 1110 IF (NRSN.EQ.0) GO TO 1340                                     DATA2740
C                                                                   DATA2745
C  TRANSIENT-STATE RAINFALL PROFILES                                DATA2750
C                                                                   DATA2755
      IF (NRFPR.EQ.0) GO TO 1130                                    DATA2760
      PRINT 11400                                                   DATA2765
      DO 1120 I=1,NRFPR                                             DATA2770
         READ 12300,(TRF(I,J),J=1,NRFPAR)                           DATA2775
         READ 12300,(RF(I,J),J=1,NRFPAR)                            DATA2780
         PRINT 11500,I                                              DATA2785
         DO 1120 J=1,NRFPAR                                         DATA2790
 1120       PRINT 12400,(TRF(I,J),RF(I,J))                          DATA2795
C                                                                   DATA2800
C  TRANSIENT-STATE RAINFALL TYPES AND PONDING DEPTHS                DATA2805
C                                                                   DATA2810
 1130 DO 1140 NP=1,NNP                                              DATA2815
 1140    IRFTYP(NP)=0                                               DATA2820
      NPP=0                                                         DATA2825
 1150 IF (NPP.EQ.NRSN) GO TO 1210                                   DATA2830
      IF (NPP.LT.NRSN) GO TO 1160                                   DATA2835
      PRINT 14800,NRSN                                              DATA2840
      ISTOP=ISTOP+1                                                 DATA2845
      GO TO 1210                                                    DATA2850
 1160 READ 13400,NI,ITYP,NPINC,HCONI                                DATA2855
      IF (NPINC.GT.0) GO TO 1180                                    DATA2860
 1170 NPP=NPP+1                                                     DATA2865
      NPRS(NPP)=NI                                                  DATA2870
      IRFTYP(NI)=ITYP                                               DATA2875
      HCON(NI)=HCONI                                                DATA2880
      GO TO 1150                                                    DATA2885
 1180 IF (NPP.GT.0) GO TO 1190                                      DATA2890
      ISTOP=ISTOP+1                                                 DATA2895
      PRINT 15500                                                   DATA2900
 1190 NJ=NPRS(NPP)                                                  DATA2905
      JTYP=IRFTYP(NJ)                                               DATA2910
      HCONJ=HCON(NJ)                                                DATA2915
      NJ=NJ+NPINC                                                   DATA2920
      NK=NI-1                                                       DATA2925
      DO 1200 NP=NJ,NK,NPINC                                        DATA2930
         NPP=NPP+1                                                  DATA2935
         NPRS(NPP)=NP                                               DATA2940
         IRFTYP(NP)=JTYP                                            DATA2945
 1200    HCON(NP)=HCONJ                                             DATA2950
      GO TO 1170                                                    DATA2955
 1210 PRINT 11600                                                   DATA2960
      DO 1220 NPP=1,NRSN                                            DATA2965
         NP=NPRS(NPP)                                               DATA2970
 1220    PRINT 13500,NP,IRFTYP(NP),HCON(NP)                         DATA2975
C                                                                   DATA2980
C  TRANSIENT-STATE RAINFALL-SEEPAGE ELEMENT SURFACE INFORMATION     DATA2985
C                                                                   DATA2990
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```
      MPI=0
 1230 IF (MPI.EQ.NRSEL) GO TO 1280
      READ 12000,MI,IS1,IS2,KINC
      IF (KINC.GT.0) GO TO 1250
 1240 MPI=MPI+1
      NRSE(MPI)=MI
      IS(MPI,1)=IS1
      IS(MPI,2)=IS2
      GO TO 1230
 1250 IF (MPI.GT.0) GO TO 1260
      ISTOP=ISTOP+1
      PRINT 15600
 1260 NPINC=IABS(IS(MPI,2)-IS(MPI,1))
      MINC=IABS(NPINC)-1
      MINC=MAX0(MINC,1)
      MJ=NRSE(MPI)+MINC
      MK=MI-1
      DO 1270 M=MJ,MK,MINC
         MPJ=MPI
         MPI=MPI+1
         NRSE(MPI)=M
         IS(MPI,1)=IS(MPJ,1)+NPINC
 1270    IS(MPI,2)=IS(MPJ,2)+NPINC
      GO TO 1240
 1280 PRINT 11700
      DO 1290 MP=1,NRSEL
         M=NRSE(MP)
 1290    PRINT 13000,M,IS(MP,1),IS(MP,2)
C
C  DETERMINE DIRECTION COSINES FOR TRANSIENT-STATE RAINFALL-SEEPAGE
C  SURFACES
C
      DO 1330 MPI=1,NRSEL
         MI=NRSE(MPI)
         DO 1320 MPJ=1,NBEL
            MJ=NBE(MPJ)
            IF (MJ.NE.MI) GO TO 1320
            IF (ISB(MPJ,1).EQ.IS(MPI,1).AND.ISB(MPJ,2).EQ.IS(MPI,2)) GO
     >        TO 1300
            IF (ISB(MPJ,1).EQ.IS(MPI,2).AND.ISB(MPJ,2).EQ.IS(MPI,1)) GO
     >        TO 1300
            GO TO 1320
 1300       DO 1310 J=1,4
 1310          IS(MPI,J)=ISB(MPJ,J)
            DL(MPI)=DLB(MPJ)
            DCOSX(MPI)=DCOSXB(MPJ)
            DCOSZ(MPI)=DCOSZB(MPJ)
            GO TO 1330
 1320       CONTINUE
         ISTOP=ISTOP+1
         PRINT 14900,MI
 1330    CONTINUE
 1340 DO 1350 NP=1,NNP
 1350    RP(NP)=0.
      IF (NBC.EQ.0) GO TO 1440
C
C  READ TRANSIENT-STATE BOUNDARY CONDITIONS OF THE FORM H=BB
C
      NPP=0
 1360 IF (NPP.EQ.NBC) GO TO 1420
```

```
      IF (NPP.LT.NBC) GO TO 1370
      PRINT 14300,NBC
      ISTOP=ISTOP+1
      GO TO 1420
 1370 READ 13300,NI,NPINC,BBI
      IF (NPINC.GT.0) GO TO 1390
 1380 NPP=NPP+1
      NN(NPP)=NI
      BB(NPP)=BBI
      GO TO 1360
 1390 IF (NPP.GT.0) GO TO 1400
      ISTOP=ISTOP+1
      PRINT 15400
 1400 NJ=NN(NPP)+NPINC
      BBJ=BB(NPP)
      NK=NI-1
      DO 1410 NP=NJ,NK,NPINC
         NPP=NPP+1
         NN(NPP)=NP
 1410    BB(NPP)=BBJ
      GO TO 1380
 1420 PRINT 11800
      DO 1430 NPP=1,NBC
 1430    PRINT 13200,NN(NPP),BB(NPP)
 1440 IF (NST.LE.0) GO TO 1540
C
C  READ TRANSIENT-STATE SURFACE-TERM POINT FLUXES
C
      NPP=0
      MP=0
      PRINT 11900
 1450 IF (MP.EQ.NST) GO TO 1500
      READ 13400,NI,NJ,KINC,EI,EJ
      IF (KINC.GT.0) GO TO 1470
 1460 MP=MP+1
      DX=X(NI)-X(NJ)
      DZ=Z(NI)-Z(NJ)
      EL=DSQRT(DX*DX+DZ*DZ)
      PRINT 13500,NI,NJ,EI,EJ
      RP(NI)=RP(NI)+EI*EL/3.0+EJ*EL/6.0
      RP(NJ)=RP(NJ)+EI*EL/6.0+EJ*EL/3.0
      NPP=NPP+1
      NPST(NPP)=NI
      NPP=NPP+1
      NPST(NPP)=NJ
      EK=EJ
      GO TO 1450
 1470 IF (MP.GT.0) GO TO 1480
      ISTOP=ISTOP+1
      PRINT 15700
 1480 NPINC=IABS(NJ-NI)
      NPMIN=MAX0(NPST(NPP),NPST(NPP-1))
      NPMAX=MIN0(NI,NJ)-1
      DO 1490 NK=NPMIN,NPMAX,NPINC
         NL=NK+NPINC
         MP=MP+1
         DX=X(NK)-X(NL)
         DZ=Z(NK)-Z(NL)
         EL=DSQRT(DX*DX+DZ*DZ)
         PRINT 13500,NK,NL,EK,EK
```

```
         RP(NK)=RP(NK)+EK*EL/2.0
         RP(NL)=RP(NL)+EK*EL/2.0
         NPP=NPP+1
         NPST(NPP)=NK
         NPP=NPP+1
         NPST(NPP)=NL
 1490    CONTINUE
      GO TO 1460
 1500 NPPMAX=NPP
      NSTN=0
      DO 1530 NPPI=1,NPPMAX
         IF (NSTN.EQ.0) GO TO 1520
         DO 1510 NPPJ=1,NSTN
            IF (NPST(NPPI).EQ.NPST(NPPJ)) GO TO 1530
 1510       CONTINUE
 1520    NSTN=NSTN+1
         NPST(NSTN)=NPST(NPPI)
 1530    CONTINUE
C
C  APPLY TRANSIENT-STATE DIRICHLET BOUNDARY CONDITIONS TO INITIAL
C  CONDITIONS
C
 1540 IF (NBC.EQ.0) GO TO 1560
      DO 1550 NPP=1,NBC
         NP=NN(NPP)
 1550    H(NP)=BB(NPP)
 1560 IF (ISTOP.EQ.0) GO TO 1570
      PRINT 15800, ISTOP
      STOP
 1570 RETURN
10000 FORMAT(35H0INPUT TABLE 1.. BASIC PARAMETERS   // 5X,
     > 40H NUMBER OF NODAL POINTS. . . . . . . . . ..I5/ 5X,
     > 40H NUMBER OF ELEMENTS. . . . . . . . . . . ..I5/ 5X,
     > 40H NUMBER OF DIFFERENT MATERIALS . . . . . ..I5/ 5X,
     > 40H NUMBER OF CORRECTION MATERIALS. . . . . ..I5/ 5X,
     > 40H NUMBER OF TIME INCREMENTS . . . . . . . ..I5/ 5X,
     > 40H STEADY-STATE I.C. CONTROL . . . . . . . ..I5/ 5X,
     > 40H SOIL-PROPERTY CONTROL . . . . . . . . . ..I5/ 5X,
     > 40H NUMBER OF SOIL PARAMETERS . . . . . . . ..I5/ 5X,
     > 40H AUXILIARY STORAGE CONTROL . . . . . . . ..I5/ 5X,
     > 40H CONDUCTIVITY-PERMEABILITY CONTROL . . . ..I5/ 5X,
     > 40H GRAVITY CONTROL . . . . . . . . . . . . ..I5/ 5X,
     > 40H RESTART PARAMETER . . . . . . . . . . . ..I5/ 5X,
     > 40H MAXIMUM ITERATIONS PER CYCLE. . . . . . ..I5/ 5X,
     > 40H MAXIMUM CYCLES PER TIME STEP. . . . . . ..I5)
10100 FORMAT(5X,40H TIME INCREMENT. . . . . . . . . . . . . ..F10.6/ 5X,
     > 40H MULTIPLIER FOR INCREASING DELT. . . . . ..F10.6/ 5X,
     > 40H MAXIMUM VALUE OF DELT . . . . . . . . . ..D10.4/ 5X,
     > 40H MAXIMUM VALUE OF TIME . . . . . . . . . ..D10.4/ 5X,
     > 40H DEGREES OF PRIN-AXIS INCLINATION. . . . ..F10.6/ 5X,
     > 40H STEADY-STATE TOLERANCE. . . . . . . . . ..F10.6/ 5X,
     > 40H TRANSIENT-STATE TOLERANCE . . . . . . . ..F10.6/ 5X,
     > 40H DENSITY OF WATER. . . . . . . . . . . . ..F10.6/ 5X,
     > 40H ACCELERATION OF GRAVITY . . . . . . . . ..F10.3/ 5X,
     > 40H VISCOSITY OF WATER. . . . . . . . . . . ..F10.6/ 5X,
     > 40H TIME-INTEGRATION PARAMETER. . . . . . . ..F10.6)
10200 FORMAT(//6X,14HOUTPUT CONTROL)
10300 FORMAT(36H1INPUT TABLE 2.. MATERIAL PROPERTIES// 9H MAT. NO., 9(
     > 3A4))
10400 FORMAT(53H1INPUT TABLE 3.. SOIL-PROPERTIES INTERPOLATION VALUES//
```

```
     > 9H MAT. NO.,9X,8HPRESSURE,13X,16HMOISTURE CONTENT,4X,
     > 25HCONDUCTIVITY/PERMEABILITY,6X,14HWATER CAPACITY)
10500 FORMAT(44H1INPUT TABLE 3.. MOISTURE-CONTENT PARAMETERS//
     > 9H MAT. NO.,8(3A4))
10600 FORMAT(40H1INPUT TABLE 4.. CONDUCTIVITY PARAMETERS// 9H MAT. NO.,
     > 2(3A4))
10700 FORMAT(33H1INPUT TABLE 5.. NODAL POINT DATA// 7X,4HNODE, 8X,1HX,
     > 14X,1HZ)
10800 FORMAT(29H1INPUT TABLE 6.. ELEMENT DATA// 11X,
     > 31HGLOBAL INDICES OF ELEMENT NODES/7X,7HELEMENT,3X,1H1,7X,1H2,
     > 7X,1H3,7X,1H4,6X,8HMATERIAL,4X,9HNODE DIFF.)
10900 FORMAT (64H CORRECTIONS TO MATERIAL TYPES AND CLASSES FOR SELECTED
     > ELEMENTS)
11000 FORMAT(45H1INPUT TABLE 7.. STEADY-STATE B.C. PARAMETERS// 5X,
     > 40H NUMBER OF BOUNDARY CONDITIONS . . . . ..I5/ 5X,
     > 40H NUMBER OF SURFACE TERMS . . . . . . . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL PROFILES . . . . . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL PARAMETERS . . . . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL-SEEPAGE ELEMENTS . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL-SEEPAGE NODES. . . ..I5)
11100 FORMAT(53H1INPUT TABLE 8.. STEADY-STATE BOUNDARY CONDITIONS OF .
     > 9HFORM H=BB//6H  NODE,7X,2HBB)
11200 FORMAT(43H1INPUT TABLE 9.. STEADY-STATE SURFACE TERMS,
     > 33H E=EI AT NODE NI, E=EJ AT NODE NJ//8X,2HNI,8X,2HNJ,10X,2HEI,
     > 13X,2HEJ/)
11300 FORMAT(43H1INPUT TABLE 10.. TRANSIENT B.C. PARAMETERS// 5X,
     > 40H NUMBER OF BOUNDARY CONDITIONS . . . . ..I5/ 5X,
     > 40H NUMBER OF SURFACE TERMS . . . . . . . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL PROFILES . . . . . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL PARAMETERS . . . . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL-SEEPAGE ELEMENTS . ..I5/ 5X,
     > 40H NUMBER OF RAINFALL-SEEPAGE NODES. . . ..I5)
11400 FORMAT(31H1INPUT TABLE 11.. RAINFALL DATA)
11500 FORMAT(/8H PROFILE,I5/8X,4HTIME,11X,4HRATE)
11600 FORMAT(51H1INPUT TABLE 12.. RAINFALL DISTRIBUTION AND PONDING//
     > 6X,4HNODE,6X,4HTYPE,5X,5HDEPTH)
11700 FORMAT(54H1INPUT TABLE 13.. RAINFALL-SEEPAGE SURFACE INFORMATION//
     >   5X,7HELEMENT,2X,6HNODE 1,2X,6HNODE 2)
11800 FORMAT(50H1INPUT TABLE 14.. BOUNDARY CONDITIONS OF FORM H=BB//
     > 6H  NODE,7X,2HBB)
11900 FORMAT(31H1INPUT TABLE 15.. SURFACE TERMS,
     > 33H E=EI AT NODE NI, E=EJ AT NODE NJ// 5H   NI,5H   NJ,6X,2HEI,
     > 12X,2HEJ/)
12000 FORMAT(16I5)
12100 FORMAT(80I1)
12200 FORMAT(10X,10I11)
12300 FORMAT(8F10.0)
12400 FORMAT(2(1PD15.4))
12500 FORMAT(I8,9D12.4)
12600 FORMAT(I8,D19.4,3D25.4/(2X,4D25.4))
12700 FORMAT(I8,9D12.4/(8X,9D12.4))
12800 FORMAT(I5,2F10.3)
12900 FORMAT(I10,2D15.4)
13000 FORMAT(I10,4I8,I10,I13)
13100 FORMAT(I10,32X,I10,32X,I10)
13200 FORMAT(I5,D15.4)
13300 FORMAT(2I5,2F10.0)
13400 FORMAT(3I5,5X,2F10.0)
13500 FORMAT(2I10,2(1PD15.4))
13600 FORMAT(I5,5X,F10.0)
```

```
13700 FORMAT(////33H TOO MANY NODAL POINTS, MAXIMUM =,I5///)
13800 FORMAT(////29H TOO MANY ELEMENTS, MAXIMUM =,I5///)
13900 FORMAT(////30H TOO MANY MATERIALS, MAXIMUM =,I5///)
14000 FORMAT(////36H TOO MANY SOIL PROPERTIES, MAXIMUM =,I5///)
14100 FORMAT(////41H TOO MANY CORRECTION MATERIALS, MAXIMUM =,I5///)
14200 FORMAT(////36H TOO MANY TIME INCREMENTS, MAXIMUM =,I5///)
14300 FORMAT(////37H CHECK BOUNDARY CONDITIONS, MAXIMUM =,I5///)
14400 FORMAT(////31H CHECK SURFACE TERMS, MAXIMUM =,I5///)
14500 FORMAT(////38H TOO MANY RAINFALL PROFILES, MAXIMUM =,I5///)
14600 FORMAT(////40H TOO MANY RAINFALL PARAMETERS, MAXIMUM =,I5///)
14700 FORMAT(////46H TOO MANY RAINFALL-SEEPAGE ELEMENTS, MAXIMUM =,I5 //
     >  /)
14800 FORMAT(////43H TOO MANY RAINFALL-SEEPAGE NODES, MAXIMUM =,I5///)
14900 FORMAT(////34H ERROR IN SURFACE CARD FOR ELEMENT,I5///)
15000 FORMAT(////28H EXECUTION HALTED BECAUSE OF,I5,13H FATAL ERRORS///)
15100 FORMAT(////30H ERROR IN NODAL-POINT CARD NO.,I5///)
15200 FORMAT(////26H ERROR IN ELEMENT CARD NO.,I5///)
15300 FORMAT(////36H ERROR IN INITIAL-CONDITION CARD NO., I5///)
15400 FORMAT(////49H ERROR IN FIRST H=BB TYPE BOUNDARY-CONDITION CARD //
     >  /)
15500 FORMAT(////48H ERROR IN FIRST RAINFALL-TYPE-PONDING-DEPTH CARD///)
15600 FORMAT(////45H ERROR IN FIRST RAINFALL-SEEPAGE ELEMENT CARD///)
15700 FORMAT(////33H ERROR IN FIRST SURFACE-TERM CARD///)
15800 FORMAT(////45H ASSEMBLY AND SOLUTION WILL NOT BE PERFORMED,,I5,
     > 19H  FATAL CARD ERRORS///)
15900 FORMAT(////40H ERROR IN MATERIAL TYPE CODE FOR ELEMENT,I5///)
      END
```

```
      SUBROUTINE VELT(VX,VZ,HT,H,AKX,AKZ,MAXEL,MAXNP)
C
C
C  FUNCTION OF SUBROUTINE--TO DETERMINE DARCY VELOCITIES VX(M,KQ) AND
C  VZ(M,KQ) AND THE TOTAL HEAD HT(NP)
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z( 690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBANC,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      DIMENSION DNX(4,4),DNZ(4,4),XQ(4),ZQ(4),VX(MAXEL,4),VZ(MAXEL,4),
     > HT(MAXNP),AKX(MAXEL,4),AKZ(MAXEL,4),H(MAXNP)
      ISTOP=0
      DO 50 M=1,NEL
C
C  FOR EACH ELEMENT M PREPARE VARIABLES XQ(IQ) AND ZQ(IQ) FOR Q4D,
C  WHICH DETERMINES DERIVATIVES DNX(IQ,KQ) AND DNZ(IQ,KQ) OF EACH OF
C  THE FOUR BASIS FUNCTIONS N(IQ) AT EACH NODAL POINT KQ
C
         DO 10 IQ=1,4
            NP=IE(M,IQ)
            XQ(IQ)=X(NP)
   10       ZQ(IQ)=Z(NP)
         CALL Q4D(DNX,DNZ,AREA,XQ,ZQ)
         IF (AREA.GT.0.0) GO TO 20
         ISTOP=ISTOP+1
```

```
      PRINT 10000,M
C
C  FOR EACH NODAL POINT KQ SUM OVER CONTRIBUTIONS FROM EACH BASIS-
C  INTERPOLATION FUNCTION N(IQ) TO OBTAIN DERIVATIVES DHX AND DHZ
C  OF THE PRESSURE H(NP)
C
   20    DO 40 KQ=1,4
            DHX=0.
            DHZ=0.
            DO 30 IQ=1,4
               NP=IE(M,IQ)
               DHX=DHX+DNX(IQ,KQ)*H(NP)
   30          DHZ=DHZ+DNZ(IQ,KQ)*H(NP)
C
C  FORM THE DARCY VELOCITIES VX(M,KQ) AND VZ(M,KQ)
C
            MTYP=IE(M,5)
            VX(M,KQ)=-AKX(M,KQ)*(DHX-SNFE)
   40       VZ(M,KQ)=-AKZ(M,KQ)*(DHZ+CSFE)
   50    CONTINUE
      IF (ISTOP.GT.0) STOP
C
C  CALCULATE THE TOTAL HEAD HT(NP)
C
      DO 60 NP=1,NNP
   60    HT(NP)=H(NP)-X(NP)*SNFE+Z(NP)*CSFE
      RETURN
10000 FORMAT(/5X,17H AREA OF ELEMENT ,I5,14H  IS NEGATIVE  /)
      END
```

```
      SUBROUTINE Q4D(DNX,DNZ,AREA,XQ,ZQ)
C
C
C  FUNCTION OF SUBROUTINE--TO COMPUTE X AND Z DERIVATIVES DNX(IQ,KQ)
C  AND DNZ(IQ,KQ) OF EACH BASIS FUNCTION N(IQ) AT EACH NODE KQ OF THE
C  ELEMENT.  RESULTS ARE IN THE GLOBAL COORDINATE SYSTEM.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION S(4),T(4),DNX(4,4),DNZ(4,4),XQ(4),ZQ(4)
      DATA S / -1.0D+00, 1.0D+00, 1.0D+00,-1.0D+00 /, T / -1.0D+00,-
     > 1.0D+00, 1.0D+00, 1.0D+00 /
C
C  EVALUATE QUANTITIES FOR USE IN THE JACOBIAN DJ/8, BELOW, NECESSARY
C  FOR TRANSFORMATION FROM GLOBAL TO LOCAL COORDINATES
C
      X12 = XQ(1) - XQ(2)
      X13 = XQ(1) - XQ(3)
      X23 = XQ(2) - XQ(3)
      X14 = XQ(1) - XQ(4)
      X24 = XQ(2) - XQ(4)
      X34 = XQ(3) - XQ(4)
      Z13 = ZQ(1) - ZQ(3)
      Z24 = ZQ(2) - ZQ(4)
      Z34 = ZQ(3) - ZQ(4)
      Z12 = ZQ(1) - ZQ(2)
```

```
      Z23 = ZQ(2) - ZQ(3)
      Z14 = ZQ(1) - ZQ(4)
      AREA = X13*Z24 - X24*Z13
C
C  LOOP OVER EACH NODE
C
      DO 10 KQ=1,4
C
C  LOCAL COORDINATES OF ANY GIVEN NODE ARE (SS,TT)
C
        SS = S(KQ)
        TT = T(KQ)
C
C  EVALUATE 'JACOBIAN'
C
        DJ = AREA + SS*(X34*Z12-X12*Z34) + TT*(X23*Z14-X14*Z23)
C
C  DETERMINE THE DERIVATIVES OF EACH BASIS FUNCTION AT NODE KQ
C
        DNZ(1,KQ)=(-X24+X34*SS+X23*TT)/DJ
        DNZ(2,KQ)=(+X13-X34*SS-X14*TT)/DJ
        DNZ(3,KQ)=(+X24-X12*SS+X14*TT)/DJ
        DNZ(4,KQ)=(-X13+X12*SS-X23*TT)/DJ
        DNX(1,KQ)=(+Z24-Z34*SS-Z23*TT)/DJ
        DNX(2,KQ)=(-Z13+Z34*SS+Z14*TT)/DJ
        DNX(3,KQ)=(-Z24+Z12*SS-Z14*TT)/DJ
        DNX(4,KQ)=(+Z13-Z12*SS+Z23*TT)/DJ
   10   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BCPREP(NCHG,MAXNP,TIME,VX,VZ,MAXEL,MXRFPR,H,AKX,AKZ)
C
C
C  FUNCTION OF SUBROUTINE--TO PREPARE BOUNDARY CONDITIONS FOR THE
C  RAINFALL-SEEPAGE NODES.  IF THE PRESSURE H(NP) BECOMES GREATER THAN
C  THE PUDDLING DEPTH HCON(NP), THEN THE RAINFALL RATE IS GREATER
C  THAN THAT WHICH CAN BE ABSORBED BY THE SOIL AND EITHER INWARD FLUX
C  CONTINUES AT A REDUCED RATE OR SEEPAGE, OUTWARD FLUX, BEGINS.
C  IN EITHER EVENT THE BOUNDARY CONDITION IS CHANGED TO THE
C  CONSTANT PUDDLING DEPTH HCON(NP).  ON THE OTHER HAND, SHOULD THE
C  INTERIOR DARCY FLUX DCYFLX(NP) BECOME GREATER THAN CAN BE MAINTAINED
C  BY THE EXTERNAL FLUX, A CHANGE TO A FLUX BOUNDARY CONDITION IS
C  EFFECTED.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/RFSP/DCYFLX(690 ),HCON(690 ),FLX(690 ),DCOSX(612 ),
     > DCOSZ(612 ),DL(612 ),TRF(2,20),RF(2,20),RFALL(2),IRFTYP(690 ),
     > NPRS(690 ),NPCON(690 ),NPFLX(690 ),NRSE(612 ),IS(612 ,4),NRFPR,
     > NRFPAR,NRSEL,NRSN
      DIMENSION H(MAXNP),VX(MAXEL,4),VZ(MAXEL,4),AKX(MAXEL,4),
```

```
      > AKZ(MAXEL,4),DFLXQ(2),KQ(2),HC(4),AKXQ(4),AKZQ(4),XQ(4),ZQ(4)
C
C     CALCULATE THE RAINFALL RFALL(I) FRCM EACH PROFILE
C
      IF (NRFPR.EQ.0) GO TO 40
      DO 30 I=1,NRFPR
         DC 20 J=2,NRFPAR
            IF (TRF(I,J-1).LE.TIME.AND.TIME.LE.TRF(I,J)) GO TO 10
            GO TO 20
10          RFALL(I)=RF(I,J-1)+(TIME-TRF(I,J-1))*(RF(I,J)-RF(I,J-1))/
     >       (TRF(I,J)-TRF(I,J-1))
            GO TO 30
20          CONTINUE
30       CONTINUE
C
C     DETERMINE THE NORMAL RAINFALLS FLX(NP) AND DARCY FLUXES DCYFLX(NP)
C     FOR EACH RAINFALL-SEEPAGE NODAL POINT
C
40    DO 50 NP=1,NNP
         FLX(NP)=0.
50       DCYFLX(NP)=0.
      DO 70 MP=1,NKSEL
         M=NRSE(MP)
         NI=IS(MP,1)
         NJ=IS(MP,2)
         NITYP=IRFTYP(NI)
         NJTYP=IRFTYP(NJ)
         RFNI=0.
         RFNJ=0.
         IF (NITYP.GT.0) RFNI=RFALL(NITYP)
         IF (NJTYP.GT.0) RFNJ=RFALL(NJTYP)
C
C     OBTAIN RAINFALL RATES RFNI ANC RFNJ AT PCINTS NI AND NJ NORMAL TO
C     THE SIDE SUBTENDED BY THESE PCINTS
C
         MTYP=IE(M,5)
         RFNI=-RFNI*DCOSZ(MP)
         RFNJ=-RFNJ*DCOSZ(MP)
C
C     OBTAIN DARCY FLUX RATES VNNI AND VNNJ AT THESE SAME POINTS AND
C     NORMAL TO THAT SAME SIDE
C
         KQ(1)=IS(MP,3)
         KC(2)=IS(MP,4)
C
C     CALCULATE RAINFALL FLUX PASSING THROUGH SIDE (NI,NJ) AND CIVIDE IT
C     INTO TWO PARTS FLX(NI) AND FLX(NJ).  PERFORM A SIMILAR OPERATION TO
C     OBTAIN LARCY FLUXES DCYFLX(NI) AND CCYFLX(NJ)
C
         FLX(NI)=FLX(NI)+RFNI*DL(MP)/3.0+RFNJ*DL(MP)/6.0
         FLX(NJ)=FLX(NJ)+RFNI*DL(MP)/6.0+RFNJ*DL(MP)/3.0
         DC 60 IQ=1,4
            NP=IE(M,IQ)
            XQ(IQ)=X(NP)
            ZC(IQ)=Z(NP)
            AKXQ(IQ)=AKX(M,IQ)
            AKZQ(IQ)=AKZ(M,IQ)
            HQ(IQ)=H(NP)
60          CONTINUE
         CALL Q4S(DFLXQ,KQ,DL(MP),DCOSX(MP),DCOSZ(MP),HQ,XQ,ZQ, AKXQ,
```

```
     >     AKZO,SNFE,CSFE,AREA)
          DCYFLX(NI)=DCYFLX(NI)+DFLXQ(1)
          DCYFLX(NJ)=DCYFLX(NJ)+DFLXQ(2)
   70     CONTINUE
C
C  CHANGE TO FLUX OR CONSTANT-HEAD CONDITIONS, AS NECESSARY, AND SO
C  INDICATE IN THE ARRAYS NPFLX(NPP) AND NPCON(NPP)
C
      IF (NCHG.NE.(-1)) GO TO 80
      NCHG=0
      RETURN
   80 NCHG=0
      DO 100 NPP=1,NRSN
          NP=NPFLX(NPP)
          IF (NP.EQ.0) GO TO 90
          IF (HCON(NP).GE.H(NP)) GO TO 100
          NPCON(NPP)=NPFLX(NPP)
          NPFLX(NPP)=0
          NCHG=NCHG+1
          GO TO 100
   90     NP=NPCON(NPP)
          IF (FLX(NP).LE.DCYFLX(NP)) GO TO 100
          NPFLX(NPP)=NPCON(NPP)
          NPCON(NPP)=0
          NCHG=NCHG+1
  100     CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BC(C,R,RP,MAXNP,MAXHBP,KSS)
C
C
C  FUNCTION OF SUBROUTINE--TO APPLY BOTH CONSTANT AND TIME-VARYING
C  (RAINFALL-SEEPAGE) FLUX-TYPE NEUMANN AND PRESSURE-TYPE DIRICHLET
C  BOUNDARY CONDITIONS.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/RFSP/DCYFLX(690 ),HCON(690 ),FLX(690 ),DCOSX(612 ),
     > DCOSZ(612 ),DL(612 ),TRF(2,20),RF(2,20),RFALL(2),IRFTYP(690 ),
     > NPRS(690 ),NPCON(690 ),NPFLX(690 ),NRSE(612 ),IS(612 ,4),NRFPR,
     > NRFPAR,NRSEL,NRSN
      DIMENSION C(MAXNP,MAXHBP),R(MAXNP),RP(MAXNP)
      IHALFB=(IBAND-1)/2
      IHBP=IHALFB+1
      IF (NBC.EQ.0) GO TO 90
C
C  APPLY CONSTANT DIRICHLET BOUNDARY CONDITIONS
C
      DO 80 NPP=1,NBC
C
C  MODIFY LOAD VECTOR FOR NON-ZERO BB
```

```
C
      NI=NN(NPP)
      IF (BB(NPP).EQ.0.0) GO TO 40
      DO 10 IB=1,IHALFB
         NJ=NI-IB
         IF (NJ.LT.1) GO TO 20
         JB=IB+1
   10    R(NJ)=R(NJ)-BB(NPP)*C(NJ,JB)
   20 DO 30 IB=1,IHALFB
         NJ=NI+IB
         IF (NJ.GT.NNP) GO TO 40
         JB=IB+1
   30    R(NJ)=R(NJ)-BB(NPP)*C(NI,JB)
   40 R(NI)=BB(NPP)
C
C  ZERO COLUMN NN
C
      DO 50 IB=1,IHALFB
         NJ=NI-IB
         IF (NJ.LT.1) GO TO 60
         JB=IB+1
   50    C(NJ,JB)=0.0
C
C  MODIFY ROW NN
C
   60 DO 70 KB=1,IHBP
   70    C(NI,KB)=0.0
      C(NI,1)=1.0
   80 CONTINUE
C
C  MODIFY LOAD VECTOR FOR CONSTANT SURFACE TERMS OF THE FORM DR/DN=C
C
   90 IF (NST.EQ.0) GO TO 110
      DO 100 NP=1,NNP
  100 R(NP)=R(NP)-RP(NP)
  110 IF (NRSN.EQ.0) GO TO 210
C
C  APPLY DIRICHLET TIME-VARIABLE (RAINFALL-SEEPAGE) CONDITIONS
C
      DO 190 NPP=1,NRSN
C
C  MODIFY LOAD VECTOR FOR NON-ZERO HCON
C
      NI=NPCON(NPP)
      IF (NI.EQ.0) GO TO 190
      IF (HCON(NI).EQ.0.0) GO TO 150
      DO 120 IB=1,IHALFB
         NJ=NI-IB
         IF (NJ.LT.1) GO TO 130
         JB=IB+1
  120    R(NJ)=R(NJ)-HCON(NI)*C(NJ,JB)
  130 DO 140 IB=1,IHALFB
         NJ=NI+IB
         IF (NJ.GT.NNP) GO TO 150
         JB=IB+1
  140    R(NJ)=R(NJ)-HCON(NI)*C(NI,JB)
  150 R(NI)=HCON(NI)
C
C  ZERO COLUMN NPCON
C
```

```
      DO 160 IB=1,IHALFB
         NJ=NI-IB
         IF (NJ.LT.1) GO TO 170
         JB=IB+1
  160    C(NJ,JB)=0.0
C
C  MODIFY ROW NPCON
C
  170 DO 180 KB=1,IHBP
  180    C(NI,KB)=0.0
      C(NI,1)=1.0
  190 CONTINUE
C
C  APPLY NEUMANN TIME-VARIABLE (RAINFALL-SEEPAGE) CONDITICNS
C
      DO 200 NPP=1,NRSN
      NP=NPFLX(NPP)
      IF (NP.EQ.0) GO TO 200
      R(NP)=R(NP)-FLX(NP)
  200 CONTINUE
  210 RETURN
      END
```

```
      SUBROUTINE ASEMBL(C,R,RP,H,HP,TH,DTH,AKX,AKZ,MAXNP, MAXHBP,MAXEL,
     > KSS,W)
C
C
C  FUNCTION OF SUBROUTINE--TO ASSEMBLE THE TOTAL COEFFICIENT MATRIX
C  C(NP,IB) AND LOAD VECTOR R(NP) FROM THE ELEMENT MATRICES QA(IQ,JQ),
C  QB(IQ,JQ), AND RQ(IQ).
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/MTL/PROP(2,5),THPRCP(2,52),AKPROP(2,52),HPROP(2,52),
     > CAPROP(2,52),NSPPM
      COMMON/Q4PAR/QB(4,4),QA(4,4),RQ(4),THQ(4),DTHQ(4),AKXQ(4), AKZQ(4)
     >  ,AREA,ALP,BETAP,POR,XQ(4),ZQ(4),SINFE,COSFE
      DIMENSION C(MAXNP,MAXHBP),R(MAXNP),TH(MAXEL,4),DTH(MAXEL,4),
     > H(MAXNP),HP(MAXNP),AKX(MAXEL,4),AKZ(MAXEL,4),IEM(4),RP(MAXNP)
      SINFE=SNFE
      COSFE=CSFE
      IHALFB=(IBAND-1)/2
      IHBP=IHALFB+1
      DELTI=1./DELT
      W1=W
      W2=1.-W
      IF (KSS.GT.0) GO TO 10
      DELTI=0.
      W1=1.
      W2=0.
C
C  INITIALIZE MATRICES C(NP,IB) AND R(NP)
```

```
C
   10 DO 20 NP=1,NNP
         R(NP)=0.0
         DO 20 IB=1,IHBP
   20       C(NP,IB)=0.0
      DO 60 M=1,NEL
C
C  COMPUTE MATRICES QA(IQ,JQ), QB(IQ,JQ), AND RQ(IQ) FOR ELEMENT M
C
         MTYP=IE(M,5)
         ALP=PROP(MTYP,1)
         BETAP=PROP(MTYP,2)
         PCR=PROP(MTYP,3)
         DO 30 IQ=1,4
            NP=IE(M,IQ)
            IEM(IQ)=NP
            XQ(IQ)=X(NP)
            ZQ(IQ)=Z(NP)
            THQ(IQ)=TH(M,IQ)
            DTHQ(IQ)=DTH(M,IQ)
            AKXQ(IQ)=AKX(M,IQ)
   30       AKZQ(IQ)=AKZ(M,IQ)
         CALL Q4
C
C  ASSEMBLE QA(IQ,JQ) AND QB(IQ,JQ) INTO THE TOTAL MATRIX
C  C(NP,IB) = B + A/DELT AND FORM THE LOAD VECTOR R(NP).
C  SINCE C IS SYMMETRIC, ONLY THE UPPER HALF BAND IS STORED
C
   40    DO 50 IQ=1,4
            NI=IEM(IQ)
            R(NI)=R(NI)-RQ(IQ)
            DO 50 JQ=1,4
               NJ=IEM(JQ)
               QA(IQ,JQ)=QA(IQ,JQ)*DELTI
               R(NI)=R(NI)+(QA(IQ,JQ)-W2*QB(IQ,JQ))*HP(NJ)
               IF (NJ.LT.NI) GO TO 50
               IB=NJ-NI+1
               C(NI,IB)=C(NI,IB)+QA(IQ,JQ)+W1*QB(IQ,JQ)
   50          CONTINUE
   60    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE Q4
C
C
C  FUNCTION OF SUBROUTINE--TO EVALUATE THE MATRIX QUADRATURES OVER THE
C  AREA OF ONE ELEMENT OF WATER CONTENT AND COMPRESSIBILITY QA(IQ,JQ)
C  AND OF CONDUCTIVITY QB(IQ,JQ) AND RQ(IQ), THE LATTER ARISING FROM THE
C  GRAVITY TERM IN THE MOISTURE-FLOW EQUATION. THESE INTEGRALS ARISE
C  THROUGH APPLICATION OF THE GALERKIN INTEGRATION SCHEME.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 N(4)
      COMMON/Q4PAR/QB(4,4),QA(4,4),RQ(4),THQ(4),DTHQ(4),AKXQ(4),AKZQ(4)
```

```
     > ,AREA,ALP,BETAP,POR,XQ(4),ZQ(4),SNFE,CSFE
      DIMENSION S(4),T(4),U(4),V(4)
      DATA P / 0.577350269189626 /, S / -1.0D+00, 1.0D+00, 1.0D+00,-
     > 1.0D+00 /, T / -1.0D+00,-1.0D+00, 1.0D+00, 1.0D+00 /
C
C  INITIALIZE MATRICES QA, QB, AND RQ
C
      DO 10 IQ=1,4
         RQ(IQ)=0.
         DO 10 JQ=1,4
            QB(IQ,JQ)=0.0
   10       QA(IQ,JQ)=0.0
C
C  EVALUATE QUANTITIES FOR USE IN THE JACOBIAN DJAC, BELOW, NECESSARY
C  FOR TRANSFORMATION FROM GLOBAL TO LOCAL COORDINATES
C
      X12 = XQ(1) - XQ(2)
      X13 = XQ(1) - XQ(3)
      X23 = XQ(2) - XQ(3)
      X14 = XQ(1) - XQ(4)
      X24 = XQ(2) - XQ(4)
      X34 = XQ(3) - XQ(4)
      Z13 = ZQ(1) - ZQ(3)
      Z24 = ZQ(2) - ZQ(4)
      Z34 = ZQ(3) - ZQ(4)
      Z12 = ZQ(1) - ZQ(2)
      Z23 = ZQ(2) - ZQ(3)
      Z14 = ZQ(1) - ZQ(4)
      AREA = X13*Z24 - X24*Z13
      DO 40 KG=1,4
C
C  DETERMINE LOCAL COORDINATES (SS,TT) OF GAUSS-INTEGRATION POINT KG
C
         SS = P*S(KG)
         TT = P*T(KG)
C
C  EVALUATE THE JACOBIAN DJAC
C
         DJ = AREA + SS*(X34*Z12-X12*Z34) + TT*(X23*Z14-X14*Z23)
         DJI = 1./DJ
         DJAC = .125*DJ
C
C  CALCULATE VALUES OF THE BASIS FUNCTIONS N(IQ) AND THEIR DERIVATIVES
C  V AND U W.R.T. X AND Z, RESPECTIVELY, AT THE GAUSS POINT KG
C
         SM = 1.0 - SS
         SP = 1.0 + SS
         TM = 1.0 - TT
         TP = 1.0 + TT
         U(1)=(-X24+X34*SS+X23*TT)*DJI
         U(2)=(+X13-X34*SS-X14*TT)*DJI
         U(3)=(+X24-X12*SS+X14*TT)*DJI
         U(4)=(-X13+X12*SS-X23*TT)*DJI
         V(1)=(+Z24-Z34*SS-Z23*TT)*DJI
         V(2)=(-Z13+Z34*SS+Z14*TT)*DJI
         V(3)=(-Z24+Z12*SS-Z14*TT)*DJI
         V(4)=(+Z13-Z12*SS+Z23*TT)*DJI
         N(1)=0.25*SM*TM
         N(2)=0.25*SP*TM
         N(3)=0.25*SP*TP
```

```
      N(4)=0.25*SM*TP
C
C  INTERPOLATE WITH THE BASIS-INTERPOLATION FUNCTIONS N(IQ) TO OBTAIN
C  VALUES OF CONDUCTIVITY AKXQP AND AKZQP, WATER CONTENT THQP, AND
C  WATER CAPACITY DTHQP AT THE GAUSS INTEGRATION POINT
C
      AKXQP=0.
      AKZQP=0.
      THQP=0.
      DTHQP=0.
      DO 20 IQ=1,4
         AKXQP=AKXQP+AKXQ(IQ)*N(IQ)
         AKZQP=AKZQP+AKZQ(IQ)*N(IQ)
         THQP=THQP+THQ(IQ)*N(IQ)
   20    DTHQP=DTHQP+DTHQ(IQ)*N(IQ)
C
C  ACCUMULATE THE SUMS TO EVALUATE THE MATRIX INTEGRALS QA(IQ,JQ),
C  QB(IQ,JQ), AND RQ(IQ)
C
      FHP=ALP*THQP/POR+BETAP*THQP+DTHQP
      AKXQP=AKXQP*DJAC
      AKZQP=AKZQP*DJAC
      FHP=FHP*DJAC
      DO 30 IQ=1,4
         RQ(IQ)=RQ(IQ)-V(IQ)*AKXQP*SNFE+U(IQ)*AKZQP*CSFE
         DO 30 JQ=1,4
            QA(IQ,JQ)=QA(IQ,JQ)+FHP*N(IQ)*N(JQ)
            QB(IQ,JQ)=QB(IQ,JQ)+V(IQ)*AKXQP*V(JQ)+U(IQ)*AKZQP*U(JQ)
   30       CONTINUE
   40 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SPROP(TH,DTH,AKX,AKZ,H,MAXEL,MAXNP)
C
C
C  FUNCTION OF SUBROUTINE--TO CALCULATE SOIL PROPERTIES, I.E. THE
C  WATER CONTENTS TH(M,IQ), WATER CAPACITIES DTH(M,IQ), AND
C  PRINCIPAL VALUES OF THE CONDUCTIVITY TENSOR AKX(M,IQ) AND AKZ(M,IQ).
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/MTL/PROP(2,5),THPROP(2,52),AKPROP(2,52),HPROP(2,52),
     > CAPROP(2,52),NSPPM
      DIMENSION TH(MAXEL,4),AKX(MAXEL,4),AKZ(MAXEL,4),DTH(MAXEL,4),
     > H(MAXNP)
      DO 70 M=1,NEL
         MTYP=IE(M,5)
         DO 60 IQ=1,4
            NP=IE(M,IQ)
            HNP=H(NP)
            IF (HNP.GT.HPROP(MTYP,1)) GO TO 10
```

```
          JL=1
          JU=2
          A=0.
          GO TO 50
 10       IF (HNP.LT.HPROP(MTYP,NSPPM)) GO TO 20
          JL=NSPPM
          JU=1
          A=0.
          GO TO 50
 20       DO 30 J=2,NSPPM
             JU=J
             IF (HPROP(MTYP,J).GT.HNP) GO TO 40
 30          CONTINUE
 40       JL=JU-1
          A=(HNP-HPROP(MTYP,JL))/(HPROP(MTYP,JU)-HPROP(MTYP,JL))
 50       TH(M,IQ)=THPROP(MTYP,JL)+A*(THPROP(MTYP,JU)-THPROP(MTYP,JL))
          DTH(M,IQ)=CAPROP(MTYP,JL)+A*(CAPROP(MTYP,JU)-CAPROP(MTYP,JL)
     >       )
C         AKX(M,IQ)=AKPROP(MTYP,JL)+A*(AKPROP(MTYP,JU)-AKPROP(MTYP,JL)
C    >       )
          AKS=AKPROP(MTYP,1)
          HC=AKPROP(MTYP,2)
          AN=AKPROP(MTYP,3)
          IF(HNP.LT.0.D0) GO TO 55
          AKX(M,IQ)=AKS
          GO TO 60
 55       AKX(M,IQ)=AKS/((HNP/HC)**AN+1.)
 60       AKZ(M,IQ)=AKX(M,IQ)
 70    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRINTT(NNP,IBAND,MAXNP,MAXEL,DELT,H,HT,VX, VZ,TH,AKX,
     > AKZ,DTH,TIME,IE,NEL,KPR,SUBHD,KOUT,BFLX,FRATE, FLOW,NRSN,NPCON,
     > NPFLX,TFLOW,KDIAG,NPRS,RSFLX)
C
C
C  FUNCTION OF SUBROUTINE--TO OUTPUT FLOWS, PRESSURE HEADS, TOTAL
C  HEADS, WATER CONTENTS, AND DARCY VELOCITIES AS SPECIFIED BY
C  PARAMETER KPR.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*4 SUBHD
      DIMENSION H(MAXNP),HT(MAXNP),BFLX(MAXNP),NPCON(MAXNP),NPFLX(MAXNP)
     >  ,NPRS(MAXNP),RSFLX(MAXNP),VX(MAXEL,4),VZ(MAXEL,4),AKX(MAXEL,4),
     > AKZ(MAXEL,4),TH(MAXEL,4),DTH(MAXEL,4),IE(MAXEL,4),SUBHD(8),
     > FRATE(10),FLOW(10),TFLOW(10)
      IF (KDIAG.NE.0) GO TO 10
      KDIAG=1
      GO TO 30
C
C  PRINT DIAGNOSTIC FLOW INFORMATION
C
  10  PRINT 10600,(FRATE(I),FLOW(I),TFLOW(I),I=1,7)
      IF (NRSN.EQ.0) GO TO 30
```

```
      DO 20 NPP=1,NRSN
         NP=NPRS(NPP)
   20    RSFLX(NPP)=BFLX(NP)
      PRINT 10700
      PRINT 10100,(RSFLX(NPP),NPP=1,NRSN)
   30 IF (KPR.EQ.0) RETURN
C
C  PRINT PRESSURE HEADS
C
      KOUT=KOUT+1
      PRINT 10200,KOUT,TIME,DELT,IBAND,(SUBHD(I),I=1,8)
      DO 40 NI=1,NNP,8
         NJMN=NI
         NJMX=MIN0(NI+7,NNP)
   40    PRINT 10000,NI,(H(NJ),NJ=NJMN,NJMX)
      IF (KPR.EQ.1) RETURN
C
C  PRINT TOTAL HEADS
C
      KOUT=KOUT+1
      PRINT 10300,KOUT,TIME,DELT,IBAND,(SUBHD(I),I=1,8)
      DO 50 NI=1,NNP,8
         NJMN=NI
         NJMX=MIN0(NI+7,NNP)
   50    PRINT 10000,NI,(HT(NJ),NJ=NJMN,NJMX)
C
C  PRINT WATER CONTENTS
C
      KOUT=KOUT+1
      PRINT 10400,KOUT,TIME,DELT,IBAND,(SUBHD(I),I=1,8)
      DO 60 M=1,NEL
   60    PRINT 10000,M,(TH(M,IQ),IQ=1,4)
      IF (KPR.EQ.2) RETURN
C
C  PRINT DARCY VELOCITIES
C
      KOUT=KOUT+1
      PRINT 10500,KOUT,TIME,DELT,IBAND,(SUBHD(I),I=1,8)
      DO 70 M=1,NEL
   70    PRINT 10000,M,(VX(M,IQ),IQ=1,4),(VZ(M,IQ),IQ=1,4)
      RETURN
10000 FORMAT(I7,8(1PD15.4))
10100 FORMAT(8D15.4)
10200 FORMAT(13H1OUTPUT TABLE,I4,27H.. PRESSURE HEADS AT TIME =,
     > 1PD12.4,9H .(DELT =,1PD12.4,15H),(BAND WIDTH =,I4,1H)//1X,8A4/
     > 7H NODE I,5X,36HPRESSURE HEAD OF NODES I,I+1,....,I+7/)
10300 FORMAT(13H1OUTPUT TABLE,I4,24H.. TOTAL HEADS AT TIME =, 1PD12.4,
     > 9H ,(DELT =,1PD12.4,15H),(BAND WIDTH =,I4,1H)//1X,8A4/ 7H NODE I,
     >   5X,33HTOTAL HEAD OF NODES I,I+1,....,I+7/)
10400 FORMAT(13H1OUTPUT TABLE,I4,27H.. WATER CONTENTS AT TIME =,
     > 1PD12.4,9H ,(DELT =,1PD12.4,15H),(BAND WIDTH =,I4,1H)//1X,8A4/
     > 37X,5HNODES/17X,1H1,14X,1H2,14X,1H3,14X,1H4/3X,7HELEMENT,2X,
     > 55H*******************************************************/)
10500 FORMAT(13H1OUTPUT TABLE,I4,29H.. DARCY VELOCITIES AT TIME =,
     > 1PD12.4,9H ,(DELT =,1PD12.4,15H),(BAND WIDTH =,I4,1H)//1X,8A4/
     > 32X,14HVEL-X AT NODES,46X,14HVEL-Z AT NODES/17X,1H1,14X,1H2,14X,
     > 1H3,14X,1H4,14X,1H1,14X,1H2,14X,1H3,14X,1H4,/3X,7HELEMENT,2X,
     > 55H*******************************************************,5X,
     > 55H*******************************************************)
10600 FORMAT(//32H TABLE OF SYSTEM-FLOW PARAMETERS//5X,
```

```
     > 13H TYPE OF FLOW,35X,4HRATE,8X,9HINC. FLOW,7X,10HTOTAL FLOW/5X
     > 40H CONSTANT-PRESSURE-NODE FLOW . . . . . .,3(E12.4,5X)/5X
     > 40H CONSTANT-FLUX-NODE FLOW . . . . . . . .,3(E12.4,5X)/5X
     > 40H SEEPAGE . . . . . . . . . . . . . . . .,3(E12.4,5X)/5X
     > 40H RAINFALL. . . . . . . . . . . . . . . .,3(E12.4,5X)/5X
     > 40H NUMERICAL LOSSES. . . . . . . . . . . .,3(E12.4,5X)/5X
     > 40H NET FLOW. . . . . . . . . . . . . . . .,3(E12.4,5X)/5X
     > 40H INCREASE IN VOLUMETRIC WATER CONTENT. ..3(E12.4,5X))
10700 FORMAT(/29H RAINFALL-SEEPAGE NODAL FLOWS)
      END
```

```
      SUBROUTINE STORE(NPROB,MAXNP,MAXEL,H,HT,VX,VZ,TH,TIME,TITLE)
C
C
C  FUNCTION OF SUBROUTINE--TO STORE PERTINENT QUANTITIES ON AUXILIARY
C  DEVICE FOR FUTURE USE BY EITHER PLOTTING OR MATERIAL-TRANSPORT
C  CODES.  WHAT DEVICE IS TO BE USED MUST BE SPECIFIED BY APPROPRIATE
C  JOB-CONTROL CARDS.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBANC,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/RFSP/DCYFLX(690 ),HCON(690 ),FLX(690 ),DCOSX(612 ),
     > DCOSZ(612 ),DL(612 ),TRF(2,20),RF(2,20),RFALL(2),IRFTYP(690 ),
     > NPRS(690 ),NPCON(690 ),NPFLX(690 ),NRSE(612 ),IS(612 ,4),NRFPR,
     > NRFPAR,NRSEL,NRSN
      DIMENSION H(MAXNP),HT(MAXNP),VX(MAXEL,4),VZ(MAXEL,4),TITLE(9),
     > TH(MAXEL,4)
      DATA NPPROB/-1/
      IF (NSTRT.GT.0) GO TO 10
      IF (NPPROB.EQ.(-1)) REWIND 1
      IF (NPPROB.EQ.NPROB) GO TO 10
      WRITE(1) (TITLE(I),I=1,9),NPROB,NNP,NEL,NTI,MAXNP
      WRITE(1) (X(NP),NP=1,NNP),(Z(NP),NP=1,NNP),((IE(M,IQ),M=1,NEL),IQ=
     >  1,4)
      NPPROB=NPROB
C
C  CONVERT FROM VOLUMETRIC TO PORE FLUX FOR PROPER LINKAGE WITH THE
C  MATERIAL-TRANSPORT CODE
C
   10 DO 30 M=1,NEL
         DO 20 IQ=1,4
            VX(M,IQ)=VX(M,IQ)/TH(M,IQ)
   20       VZ(M,IQ)=VZ(M,IQ)/TH(M,IQ)
   30    CONTINUE
      WRITE(1) TIME,(H(NP),NP=1,NNP),(HT(NP),NP=1,NNP),((TH(M,IQ),M=1,
     > NEL),IQ=1,4),((VX(M,IQ),M=1,NEL),IQ=1,4),((VZ(M,IQ),M=1,NEL), IQ=
     > 1,4),(NPCON(NP),NP=1,MAXNP),(NPFLX(NP),NP=1,MAXNP)
      RETURN
      END
```

```
      SUBROUTINE SURF
C
C
C  FUNCTION OF SUBROUTINE--TO IDENTIFY BOUNDING SIDES THROUGH THE ARRAY
C  ISB(MP,4), TO CALCULATE THEIR LENGTHS DLB(MP), AND TO DETERMINE THE
C  DIRECTION COSINES DCOSX(MP) AND DCOSZ(MP) OF THE OUTWARDLY DIRECTED
C  UNIT NORMAL VECTOR FOR EACH BOUNDARY ELEMENT NBE(MP).
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
C
C  FIND SURFACE SIDES BY LOCATING NONDUPLICATED SIDES
C
      NBEL=0
      DO 40 MI=1,NEL
         DO 30 IQ=1,4
            IQ1=IQ+1
            IF (IQ.EQ.4) IQ1=1
            DO 20 MJ=1,NEL
               IF (MJ.EQ.MI) GO TO 20
               DO 10 JQ=1,4
                  JQ1=JQ+1
                  IF (JQ.EQ.4) JQ1=1
                  IF (IE(MI,IQ).EQ.IE(MJ,JQ).AND.IE(MI,IQ1).EQ.IE(MJ,
     >             JQ1)) GO TO 30
                  IF (IE(MI,IQ).EQ.IE(MJ,JQ1).AND.IE(MI,IQ1).EQ.IE(MJ,
     >             JQ)) GO TO 30
   10             CONTINUE
   20          CONTINUE
            NBEL=NBEL+1
            NBE(NBEL)=MI
            ISB(NBEL,1)=IE(MI,IQ)
            ISB(NBEL,2)=IE(MI,IQ1)
            ISB(NBEL,3)=IQ
            ISB(NBEL,4)=IQ1
   30       CONTINUE
   40    CONTINUE
C
C  CALCULATE SIDE LENGTHS AND DIRECTION COSINES
C
      DO 70 MP=1,NBEL
         M=NBE(MP)
         NI=ISB(MP,1)
         NJ=ISB(MP,2)
         DX=X(NI)-X(NJ)
         DZ=Z(NI)-Z(NJ)
         DLB(MP)=DSQRT(DX*DX+DZ*DZ)
         DCOSXB(MP)=DABS(DZ)/DLB(MP)
         DCOSZB(MP)=DABS(DX)/DLB(MP)
         DO 50 KQ=1,4
            NK=IE(M,KQ)
            IF (KQ.NE.ISB(MP,3).AND.KQ.NE.ISB(MP,4)) GO TO 60
   50       CONTINUE
   60    AM=1.
```

```
      AMI=1.
      IF (DX.NE.0.D0) AM=DZ/DX
      IF (DZ.NE.0.D0) AMI=DX/DZ
      XO=X(NI)+AMI*(Z(NK)-Z(NI))
      ZO=Z(NI)+AM*(X(NK)-X(NI))
      IF (Z(NK).GT.ZO) DCOSZB(MP)=-DCOSZB(MP)
      IF (X(NK).GT.XO) DCOSXB(MP)=-DCOSXB(MP)
   70 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SFLOW(VX,VZ,TH,BFLX,BFLXP,FRATE,FLOW,MAXEL,MAXNP,TFLOW,
     > KFLOW,H,AKX,AKZ)
C
C
C FUNCTION OF SUBROUTINE--TO COMPUTE BOUNDARY FLUXES, FLOW RATES,
C INCREMENTAL FLOWS OCCURRING DURING TIME DELT, TOTAL FLOWS SINCE
C TIME ZERO, AND THE CHANGE IN MOISTURE CONTENT FOR THE ENTIRE
C SYSTEM DURING TIME DELT.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/GEOM/X(690 ),Z(690 ),BB(690 ),DCOSXB(612 ),DCOSZB(612 ),
     > DLB(612 ),DELT,CHNG,DELMAX,TMAX,SNFE,CSFE,NN(690 ),NPST(690 ),
     > NBE(612 ),IE(612 ,5),ISB(612 ,4),NNP,NEL,NMAT,IBAND,NBC,NST,NTI,
     > NBEL,NSTN,NSTRT
      COMMON/RFSP/DCYFLX(690 ),HCON(690 ),FLX(690 ),DCOSX(612 ),
     > DCOSZ(612 ),DL(612 ),TRF(2,20),RF(2,20),RFALL(2),IFFTYP(690 ),
     > NPRS(690 ),NPCON(690 ),NPFLX(690 ),NRSE(612 ),IS(612 ,4),NRFPR,
     > NRFPAR,NRSEL,NRSN
      DIMENSION VX(MAXEL,4),VZ(MAXEL,4),TH(MAXEL,4), BFLX(MAXNP),
     > BFLXP(MAXNP),XQ(4),ZQ(4), THQ(4),FRATE(10),FLOW(10),TFLOW(10),
     > DFLXQ(2),KQ(2),HQ(4),H(MAXNP),AKXQ(4),AKZQ(4),AKX(MAXEL,4),
     > AKZ(MAXEL,4)
C
C CALCULATE NODAL FLOW RATES
C
      DO 10 NP=1,NNP
         BFLXP(NP)=BFLX(NP)
   10    BFLX(NP)=0.
      DO 30 MP=1,NBEL
         M=NBE(MP)
         NI=ISB(MP,1)
         NJ=ISB(MP,2)
         KQ(1)=ISB(MP,3)
         KQ(2)=ISB(MP,4)
         DO 20 IQ=1,4
            NP=IE(M,IQ)
            XQ(IQ)=X(NP)
            ZQ(IQ)=Z(NP)
            AKXQ(IQ)=AKX(M,IQ)
            AKZQ(IQ)=AKZ(M,IQ)
            HQ(IQ)=H(NP)
   20       CONTINUE
         CALL Q4S(DFLXQ,KQ,DLB(MP),DCCSXB(MP),DCOSZB(MP),HQ,XQ,ZQ, AKXQ,
     >    AKZQ,SNFE,CSFE,AREA)
```

```
            BFLX(NI)=BFLX(NI)+DFLXC(1)
            BFLX(NJ)=BFLX(NJ)+DFLXC(2)
   30       CCNTINUE
         IF (KFLOW.EQ.0) GO TO 60
         DO 40 NP=1,NNP
   40       BFLXP(NP)=BFLX(NP)
         DO 50 I=1,6
   50       TFLOW(I)=0.
         IF (KFLOW.EQ.(-1)) TFLOW(7)=0.
         IF (KFLOW.EQ.(-1)) QTH=0.
         KFLOW=0
C
C  DETERMINE FLOWS AND FLOW RATES THRCUGH THE VARICUS
C  TYPES CF BOUNDARY NODES, STARTING WITH THE
C  NET FLOWS THROUGH ALL BOUNDARY NODES.
C
   60 SUM=0.
         SUMP=0.
         DO 7C NP=1,NNP
            SUM=SUM+BFLX(NP)
   70       SUMP=SUMP+BFLXP(NP)
         FRATE(6)=SUM
         FLOW(6)=.5*(SUM+SUMP)*DELT
C
C  CONSTANT DIRICHLET BOUNDARY NCDES
C
         FRATE(1)=0.
         FLOW(1)=0.
         IF (NBC.LE.0) GO TO 90
         SUM=0.
         SUMP=0.
         DO 80 NPP=1,NBC
            NP=NN(NPP)
            SUM=SUM+BFLX(NP)
   80       SUMP=SUMP+BFLXP(NP)
         FRATE(1)=SUM
         FLOW(1)=.5*(SUM+SUMP)*DELT
C
C  CONSTANT NEUMANN BOUNDARY NODES
C
   90 FRATE(2)=0.
         FLOW(2)=0.
         IF (NST.LE.0) GO TO 110
         SUM=0.
         SUMP=0.
         DO 100 NPP=1,NSTN
            NP=NPST(NPP)
            SUM=SUM+BFLX(NP)
  100       SUMP=SUMP+BFLXP(NP)
         FRATE(2)=SUM
         FLOW(2)=.5*(SUM+SUMP)*DELT
C
C  RAINFALL-SEEPAGE BOUNDARY NODES
C
  110 FRATF(3)=0.
         FLOW(3)=0.
         FRATE(4)=0.
         FLOW(4)=0.
         SUMS=0.
         SUMSP=0.
```

```
      SUMR=0.
      SUMRP=0.
      IF (NRSN.LE.0) GO TO 140
      DO 130 NPP=1,NRSN
         NP=NPRS(NPP)
         BFLXA=.5*(BFLX(NP)+BFLXF(NP))
         IF (BFLXA.LT.0.D0) GO TC 120
         SUMS=SUMS+BFLX(NP)
         SUMSP=SUMSP+BFLXA
         GC TO 130
  120    SUMR=SUMR+BFLX(NP)
         SUMRP=SUMRP+BFLXA
  130    CONTINUE
      FRATE(3)=SUMS
      FLOW(3)=SUMSP*DELT
      FRATE(4)=SUMR
      FLOW(4)=SUMRP*DELT
C
C  NUMERICAL FLOW THROUGH UNSPECIFIED BCUNDARY NODES
C
  140 SUM=0.
      SUMP=0.
      DO 150 I=1,4
         SUM=SUM+FRATE(I)
  150    SUMP=SUMP+FLOW(I)
      FRATE(5)=FRATE(6)-SUM
      FLOW(5)=FLOW(6)-SUMP
C
C  FINALLY, CALCULATE THE INCREASE IN THE INTEGRATED WATER CONTENT
C
      QTHP=QTH
      QTH=0.
      DO 170 M=1,NEL
         DO 160 IQ=1,4
            NP=IE(M,IQ)
            XQ(IQ)=X(NP)
            ZQ(IQ)=Z(NP)
  160       THQ(IQ)=TH(M,IQ)
         CALL Q4TH(THQ,QTHM,AREA,XQ,ZQ)
         QTH=QTH+QTHM
  170    CONTINUE
      FLOW(7)=QTH-QTHP
      FRATE(7)=FLOW(7)/DELT
      DO 180 I=1,7
  180    TFLOW(I)=TFLOW(I)+FLOW(I)
      RETURN
      END
```

```
      SUBROUTINE Q4S(DFLXQ,KQ,DL,DCOSXQ,DCOSZQ,HQ,XQ,ZQ,AKXQ,AKZQ, SNFE,
     > CSFE,AREA)
C
C
C  FUNCTION OF SUBROUTINE--TO EVALUATE THE NORMAL-FLUX INTEGRAL
C  ALONG THE BOUNDARY LINE EXTENCING FRCM NODE LQ TO NODE MQ.
C
C
```

```
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 N(4)
      DIMENSION S(4,4),T(4,4),U(4),V(4),DFLXQ(2),KC(2),HQ(4),SSA(2),
     > TTA(2),XQ(4),ZQ(4),AKXQ(4),AKZC(4)
      DATA S/0.D0,-.57735D0,0.D0,-1.D0,.57735D0,0.D0,1.D0,0.D0, 0.D0,
     > 1.D0,0.D0,-.57735D0,-1.D0,0.D0,.57735D0,0.D0/, T/0.D0,-1.D0,0.D0,
     > -.57735D0,-1.D0,0.D0,-.57735D0,0.D0,0.D0, .57735D0,0.D0,1.D0,
     > .57735D0,0.D0,1.D0,0.D0/
C
C  INITIALIZE NODAL COMPONENTS OF LINE INTEGRAL
C
      DO 10 IQ=1,2
   10    DFLXQ(IQ)=0.
C
C  EVALUATE QUANTITIES FOR USE IN THE JACOBIAN DJAC, BELOW, NECESSARY
C  FOR TRANSFORMATION FROM GLOBAL TO LOCAL COORDINATES
C
      X12 = XQ(1) - XQ(2)
      X13 = XQ(1) - XQ(3)
      X23 = XC(2) - XQ(3)
      X14 = XQ(1) - XQ(4)
      X24 = XQ(2) - XQ(4)
      X34 = XQ(3) - XQ(4)
      Z13 = ZQ(1) - ZQ(3)
      Z24 = ZQ(2) - ZQ(4)
      Z34 = ZQ(3) - ZQ(4)
      Z12 = ZQ(1) - ZQ(2)
      Z23 = ZQ(2) - ZQ(3)
      Z14 = ZQ(1) - ZQ(4)
      AREA = X13*Z24 - X24*Z13
C
C  DETERMINE LOCAL COORDINATES OF GAUSS-INTEGRATION POINTS KG
C
      LQ=KC(1)
      MQ=KQ(2)
      SSA(1)=S(LQ,MQ)
      TTA(1)=T(LQ,MQ)
      SSA(2)=S(MQ,LQ)
      TTA(2)=T(MQ,LQ)
      DO 30 KG=1,2
         SS = SSA(KG)
         TT = TTA(KG)
C
C  EVALUATE THE JACOBIAN DJAC
C
         DJ = AREA + SS*(X34*Z12-X12*Z34) + TT*(X23*Z14-X14*Z23)
         DJI = 1./DJ
         DJAC = .125*DJ
C
C  CALCULATE VALUES OF THE BASIS FUNCTIONS N(IQ) AND THEIR DERIVATIVES
C  V AND U W.R.T. X AND Z, RESPECTIVELY, AT THE GAUSS POINT KG
C
         SM = 1.0 - SS
         SP = 1.0 + SS
         TM = 1.0 - TT
         TP = 1.0 + TT
         U(1)=(-X24+X34*SS+X23*TT)*DJI
         U(2)=(+X13-X34*SS-X14*TT)*DJI
         U(3)=(+X24-X12*SS+X14*TT)*DJI
         U(4)=(-X13+X12*SS-X23*TT)*DJI
```

```
      V(1)=(+Z24-Z34*SS-Z23*TT)*DJI
      V(2)=(-Z13+Z34*SS+Z14*TT)*DJI
      V(3)=(-Z24+Z12*SS-Z14*TT)*DJI
      V(4)=(+Z13-Z12*SS+Z23*TT)*DJI
      N(1)=0.25*SM*TM
      N(2)=0.25*SP*TM
      N(3)=0.25*SP*TP
      N(4)=0.25*SM*TP
C
C  INTERPOLATE WITH FUNCTIONS N(IC), V(IQ), AND U(IC) TO CBTAIN
C  VALUES OF CONDUCTIVITIES AKXQP AND AKZCP AND CAPILLARY GRADIENTS DHX
C  AND DHZ AT THE GAUSS INTEGRATICN PCINT KG
C
      AKXQP=0.
      AKZCP=0.
      DHX=C.
      DHZ=0.
      DO 20 IQ=1,4
         AKXQP=AKXQP+AKXQ(IQ)*N(IQ)
         AKZQP=AKZQP+AKZQ(IQ)*N(IQ)
         DHX=DHX+V(IQ)*HQ(IQ)
   20    DHZ=DHZ+U(IQ)*HQ(IQ)
C
C  EVALUATE THE NORMAL FLUX AT THE GAUSS POINT AND ACCUMULATE THE
C  INTEGRAL SUM
C
      VXQP=-AKXQP*(DHX-SNFE)
      VZQP=-AKZQP*(DHZ+CSFE)
      VNQP=VXQP*DCOSXQ+VZQP*DCOSZQ
      DFLXQ(1)=DFLXQ(1)+N(LQ)*VNQP
      DFLXC(2)=DFLXQ(2)+N(MQ)*VNCP
   30 CONTINUE
      DO 4C IQ=1,2
   40 DFLXQ(IQ)=.5*DL*DFLXQ(IC)
      RETURN
      END
```

```
      SUBROUTINE Q4TH(THQ,QTHM,AREA,XC,ZQ)
C
C
C  FUNCTION OF SUBROUTINE--TO EVALUATE THE WATER-CONTENT  INTEGRAL
C  OVER THE AREA OF ONE ELEMENT.
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 N(4)
      DIMENSICN THQ(4),S(4),T(4),XC(4),ZQ(4)
      DATA P / 0.577350269189626 /, S / -1.0D+00, 1.0D+00, 1.0D+00,-
     > 1.0D+00 /, T / -1.0D+00,-1.0D+00, 1.0D+00, 1.0D+00 /
C
C  EVALUATE QUANTITIES FOR USE IN THE JACCBIAN DJAC, BELOW, NECESSARY
C  FOR TRANSFORMATION FROM GLOBAL TO LOCAL COORDINATES
C
      X12 = XQ(1) - XQ(2)
      X13 = XQ(1) - XQ(3)
      X23 = XQ(2) - XQ(3)
```

```
      X14 = XQ(1) - XQ(4)
      X24 = XQ(2) - XQ(4)
      X34 = XQ(3) - XQ(4)
      Z13 = ZQ(1) - ZQ(3)
      Z24 = ZQ(2) - ZQ(4)
      Z34 = ZQ(3) - ZQ(4)
      Z12 = ZQ(1) - ZQ(2)
      Z23 = ZQ(2) - ZQ(3)
      Z14 = ZQ(1) - ZQ(4)
      AREA = X13*Z24 - X24*Z13
      QTHM=0.
      DO 20 KG=1,4
C
C  DETERMINE LOCAL COORDINATES (SS,TT) OF GAUSS-INTEGRATICN POINT KG
C
         SS = P*S(KG)
         TT = P*T(KG)
C
C  EVALUATE THE JACOBIAN DJAC
C
         DJ = AREA + SS*(X34*Z12-X12*Z34) + TT*(X23*Z14-X14*Z23)
         DJAC = .125*DJ
C
C  CALCULATE VALUES OF THE BASIS-INTERPCLATION FUNCTIONS N(IQ)
C
         SM = 1.0 - SS
         SP = 1.0 + SS
         TM = 1.0 - TT
         TP = 1.0 + TT
         N(1)=0.25*SM*TM
         N(2)=0.25*SP*TM
         N(3)=0.25*SP*TP
         N(4)=0.25*SM*TP
C
C  INTERPOLATE TO OBTAIN THE WATER CONTENT THQP AT THE GAUSS POINT KG
C
         THQP=0.
         DO 10 IQ=1,4
   10       THQP=THQP+THQ(IQ)*N(IQ)
C
C  ACCUMULATE THE SUM TO EVALUATE THE INTEGRAL
C
         QTHM=QTHM+THQP*DJAC
   20    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BANSOL(KKK,C,R,NNP,IHBP,MAXNP,MAXHBP)
C
C
C  FUNCTION OF SUBROUTINE--TO SCLVE THE MATRIX EQUATION CX = R,
C  RETURNING THE SOLUTION X IN R.  IT IS ASSUMED THAT THE ARRAY
C  C(NP,IB) CCNTAINS ONLY THE UPPER HALF BAND OF A SYMMETRIC MATRIX.
C
C
      IMPLICIT REAL*8(A-H,O-Z)
```

```
      DIMENSION C(MAXNP,MAXHBP),R(MAXNP)
      IHALFB=IHBP-1
      NNP1=NNP-1
C
C  IF KKK = 1, THEN TRIANGULARIZE THE BAND MATRIX C(NP,IB), BUT
C  IF KKK = 2, THEN SIMPLY SOLVE WITH THE NEW RIGHT-HAND SIDE R(NP)
C
      IF (KKK.EQ.2) GO TO 50
C
C  TRIANGULARIZE MATRIX C
C
      NU=NNP-IHALFB
      DO 20 NI=1,NU
         NJ=NI-1
         PIVOTI=1./C(NI,1)
         DO 20 LB=2,IHBP
            A=C(NI,LB)*PIVOTI
            NK=NJ+LB
            JB=0
            DO 10 KB=LB,IHBP
               JB=JB+1
   10          C(NK,JB)=C(NK,JB)-A*C(NI,KB)
   20       C(NI,LB)=A
      NL=NU+1
      DO 40 NI=NL,NNP1
         NJ=NI-1
         MB=NNP-NJ
         PIVOTI=1./C(NI,1)
         DO 40 LB=2,MB
            A=C(NI,LB)*PIVOTI
            NK=NJ+LB
            JB=0
            DO 30 KB=LB,MB
               JB=JB+1
   30          C(NK,JB)=C(NK,JB)-A*C(NI,KB)
   40       C(NI,LB)=A
      RETURN
C
C  MODIFY LOAD VECTOR R
C
   50 NU=NNP-IHALFB
      DO 60 NI=1,NU
         NJ=NI-1
         A=R(NI)
         R(NI)=A/C(NI,1)
         DO 60 LB=2,IHBP
            NK=NJ+LB
   60       R(NK)=R(NK)-C(NI,LB)*A
      NL=NU+1
      DO 70 NI=NL,NNP1
         NJ=NI-1
         MB=NNP-NJ
         A=R(NI)
         R(NI)=A/C(NI,1)
         DO 70 LB=2,MB
            NK=NJ+LB
   70       R(NK)=R(NK)-C(NI,LB)*A
C
C  BACK-SOLVE
C
```

```
      R(NNP)=R(NNP)/C(NNP,1)                                            BANS 345
      DO 80 IB=1,IHALFB                                                 BANS 350
         NI=NNP-IB                                                      BANS 355
         NJ=NI-1                                                        BANS 360
         MB=IB+1                                                        BANS 365
         DO 80 KB=2,MB                                                  BANS 370
            NK=NJ+KB                                                    BANS 375
80          R(NI)=R(NI)-C(NI,KB)*R(NK)                                  BANS 380
      DO 90 IB=IHBP,NNP1                                                BANS 385
         NI=NNP-IB                                                      BANS 390
         NJ=NI-1                                                        BANS 395
         DO 90 KB=2,IHBP                                                BANS 400
            NK=NJ+KB                                                    BANS 405
90          R(NI)=R(NI)-C(NI,KB)*R(NK)                                  BANS 410
      RETURN                                                            BANS 415
      END                                                               BANS 420
```

APPENDIX D

DEFINITION OF VARIABLES

AKPAR	Data array for storing table heading for output of conductivity parameters.
AKPROP(MTYP,I)	Conductivity (AK) or permeability parameters where MTYP is the material type and I is the specific parameter.
AKX(M,IQ)	Conductivity component in the X-direction. . .L/T.
AKXQ(IQ)	X-component of the conductivity at the four corner nodes of element M. . .L/T.
AKXQP	X-component of the conductivity at a Gauss-integration point. . .L/T.
AKZ(M,IQ)	Conductivity component in the Z-direction. . .L/T.
AKZQ(IQ)	Z-component of the conductivity at the four corner nodes of element M. . .L/T.
AKZQP	Z-component of the conductivity at a Gauss-integration point. . .L/T.
ALP	Modified coefficient of compressibility of the medium. . .L**(-1).
AM	Slope of a boundary side of element M used for determining signs of the direction cosines of an outwardly directed unit normal.
AMI	1/AM.
AREA	Diagnostic element variable. . .L**2.
BB(NPP)	Array for storing the constant pressures for Dirichlet boundary conditions. . .L.
BETAP	Modified coefficient of compressibility of water. . .L**(-1).
BFLX(NP)	Normal boundary flux attributable to node NP. . .L**3/L/T.
BFLXP(NP)	Same as BFLX but for previous time step. . .L**3/L/T.
C(NP,IB)	Assembled matrix W*B + A/DELT where B is the spatial operator matrix and A contains the coefficients associated with the time-derivative terms. . .L/T.

CAPROP(MTYP,I)	Interpolation points on specific moisture capacity (DTH) where MTYP is the material type and I is the interpolation point. . .L**(-1).
CHNG	Multiplier for increasing the time increment.
CSFE,COSFE	Cosine of angle FE.
DCOSX(MP)	Direction cosine of outwardly directed surface normal (with respect to the X-axis) for rainfall-seepage surface as a function of the boundary element.
DCOSXB(MP)	Same as DCOSX(MP), but for all bounding surfaces.
DCOXZ(MP)	Direction cosine of outwardly directed surface normal (with respect ot the Z-axis) for rainfall-seepage surface as a function of the boundary element.
DCOSZB(MP)	Same as DCOSZ(MP), but for all bounding surfaces.
DCYFLX(NP)	That portion of the boundary-line integral of the Darcy flux associated with node NP. . .L**3/L/T.
DELMAX	Maximum value of DELT. . .T.
DELT	Time increment. . .T.
DELTI	1/DELT. . .T**(-1).
DHX	Derivative of H with respect to X. . .L/L.
DHZ	Derivative of H with respect to Z. . .L/L.
DJ	Jacobian times 8. . .L**2.
DJAC	Jacobian used in the transformation from global to local coordinates for one element. . .L**2.
DL(MP)	Length of rainfall-seepage boundary side of element MP. . .L.
DLB(MP)	Length of any boundary side of element MP. . .L.
DNX	Derivative of the basis function with respect to X at the nodal points. . .L**(-1).
DNZ	Derivative of the basis functicn with respect to Z at the nodal points. . .L**(-1).

DTH(M,IQ)	Derivative of moisture content with respect to pressure head at the nodes IQ of each element M. . .L**(-1).
DTHQ(IQ)	Derivative of moisture content with respect to pressure head at the four corner nodes of element M. . .L**(-1).
DTHQP	Derivative of moisture content with respect to pressure head at a Gauss-integration point. . .L**(-1).
DX	Incremental distance in the X-direction. . .L.
DZ	Incremental distance in the Z-direction. . .L.
EI,EJ,EK	Normal fluxes to be used for flux-type boundary conditions. . .L**3/L**2/T.
EL	Length of an element side where flux-type boundary condition is applied. . .L.
FE	Angle between the coordinate axes and the principal directions of the conductivity tensor. . .degrees.
FLOW(I)	Flows across the system boundary during time DELT through constant pressure Dirichlet nodes (I=1), through constant flux Neumann points (I=2), by seepage (I=3), from rainfall (I=4), due to numerical losses (I=5), and total flux (I=6). FLOW(7) is the net increase in volumetric water content during DELT. . .L**3/L.
FLX(NP)	Component of rainfall flux normal to the boundary at node NP. . .L**3/L/T.
FRATE(I)	Flow rates at a given time corresponding to FLOW(I). . .L**3/L/T.
GRAV	Acceleration of gravity. . .L/T**2.
H(NP)	Pressure head. . .L.
HCON(NP)	Ponding depth at boundary node NP. . .L.
HP(NP)	Pressure head at the previous time increment. . .L.
HPROP(MTYP,I)	Interpolation points on pressure head (H) where MTYP is the material type and I is the specific point. . .L.
HT(NP)	Total head. . .L.

HW(NP)	Pressure head at time-integration point, i.e. HW(NP)=W*H(NP)+(1-W)*HP(NP). . .L.
IB,JB,KB	Indices ranging over the band width of the coefficient matrix.
IBAND	Band width of assembled coefficient matrix.
ICY	Cycle index made necessary by pressure and flux-dependent rainfall-seepage boundary conditions.
IE(M,IQ)	Element identification array. M is the element number, M=1,2,...NEL, IQ=1,2,3,4 denotes corner nodes of the element, and IQ=5 denotes MTYP for the element.
IHALFB	(IBAND-1)/2.
IHBP	IHALFB+1.
IQ,JQ,KQ	Local node or basis-function identifier for a given element having a value of 1,2,3, or 4.
IRFTYP(NP)	Rainfall-type parameter used to identify the rainfall profile to be used at a given boundary nodal point NP.
IS(MP,I)	Surface identification array for rainfall-seepage elements. I=1 and 2 denote nodal points of the boundary sides of the element.
ISB(MP,I)	Same as IS(MP,I) but for all boundary elements.
ISTOP	Index used to count data errors.
IT	Iteration index.
ITM	Index for simulation time.
KCP	Conductivity-permeability control. If equal 0, then conductivity data are to be input; otherwise permeability values will be read.
KDIAG	Diagnostic control variable.
KDIG	Diagnostic output table counter.
KFLOW	Control integer used for surface-flow calculation.
KG	Identifier of the four Gauss integration points within each element.

KGRAV	Gravity control parameter. If equal zero, the gravity term is omitted from both Richards equation and the definitions of total head. If equal one, gravity remains.
KINC	Incrementation control used for automatic generation of boundary conditions.
KKK	In BANSOL, index designating function to be performed. KKK=1 for triangularization and KKK=2 for backward substitution.
KOUT	Output table counter.
KPR(ITM)	Printer control for transient problems similar to KPRO as a function of the time index ITM. Used to output desired information at each time increment.
KPRO	Printer control for steady state and initial conditions. If KPRO equals zero, only the flow variables FLOW, FRATE, and TFLOW are output. If KPRO equals 1, then pressure head and flow variables are printed. If KPRO equals 2, total head, water content, and those variables that have been mentioned previously will be printed. If KRPO equals 3, then the same variables as for KRPO=2 plus the Darcy velocities are printed.
KSP	Soil properties control. If KSP equals 0, then analytical-function parameters are input. If it equals 1, then tabular data are input.
KSS	If KSS is equal to zero, the steady-state solution is obtained either as an initial condition for a transport problem or as the final solution (NTI=0). If KSS equals 1, the transient solution is obtained.
KSTR	Control parameter for storage of output on auxiliary storage (tape or disk). If KSTR equals 0, there is no storage, but if it does not equal 0, there is storage.
KX	Component of conductivity or permeability in the X-direction.
KZ	Component of conductivity or permeability in the Z-direction.
M,MI,MJ,MK	Element number.

MAXCY	Maximum number of cycles permitted for rainfall-seepage boundary-condition adjustments.
MAXDIF	Maximum nodal difference for all elements.
MAXEL	Maximum number of elements.
MAXHBP	Maximum value of IHALFB+1.
MAXIT	Maximum number of iterations.
MAXMAT	Maximum number of materials.
MAXNP	Maximum number of nodal points.
MAXNTI	Maximum number of time increments.
MINC	Increment in element number.
MND	Maximum nodal difference for a given element.
MODL	Number of elements per layer.
MP,MPI,MPJ	Compressed element index.
MTYP	Material type.
MXRFPR	Maximum number of rainfall profiles.
MXRPAR	Maximum number of parameters, i.e., interpolation points, per rainfall profile.
MXSPPM	Maximum number of soil properties per material.
N(IQ)	Basis vector for node IQ.
NAKPPM	Number of AK parameters per material.
NBC	Number of constant Dirichlet boundary conditions.
NBE(MP)	Array of boundary-element numbers.
NBEL	Number of boundary elements.
NCHG	Number of changes in the rainfall-seepage boundary conditions.
NCM	Number of elements with corrected material properties.
ND	Nodal difference.

NEL	Number of elements.
NIT	Maximum number of iterations allowed.
NITYP,NJTYP	Rainfall profile types at nodes NI and NJ, respectively.
NLAY	Number of layers of elements in regular part of grid.
NMAT	Number of different materials.
NMPPM	Number of material properties per material.
NN(NPP)	Array for storing the node numbers where constant Dirichlet boundary conditions occur.
NNCVN	Number of nodes for which there is no convergence.
NNP	Number of nodal points.
NP,NI,NJ,NK,NL	Nodal-point number.
NPCNV(NPP)	Nodes at which there is no convergence.
NPCON(NPP)	Rainfall-seepage nodal points having constant boundary conditions.
NPFLX(NPP)	Rainfall-seepage nodal points having flux boundary conditions.
NPINC	Nodal-point increment used in automatic generation of boundary conditions.
NPP,NPPI,NPPJ	Compressed nodal-point index.
NPROB	Problem number.
NPRS(NPP)	Absolute node index as a function of compressed index for rainfall-seepage boundary nodes.
NPST(NPP)	Nodal points at which constant-flux boundary conditions are to be applied.
NRFPAR	Number of parameters in each rainfall profile.
NRFPR	Number of rainfall profiles.
NRSE(MP)	Absolute rainfall-seepage element index as a function of compressed index.

NRSEL	Number of elements having rainfall-seepage boundary conditions.
NRSN	Number of nodes having rainfall-seepage conditions.
NSPPM	Number of soil properties per material.
NST	Number of element sides on which flux-type boundary conditions are applied.
NSTN	Number of nodes at which flux-type boundary conditions are applied.
NSTRT	Number of logical records to be read from auxiliary storage device for restarting the calculation. If restarting is not to be used, then NSTRT=0.
NTHPPM	Number of water content parameters per material.
NTI	Number of time increments.
PI	3.14159265
PKFC	Permeability-conductivity conversion factor.
PMAT	Data array for storing the names of material properties of the soil system. These properties are stored in PROP(MTYP,I).
POR	Porosity of the medium.
PROP(MTYP,I)	Material property where MTYP is the material type and I is the specific material property.
QA(IQ,JQ)	A matrix for element M. . .L.
QB(IQ,JQ)	B matrix for element M. . .L/T.
QTH	Net water content, i.e., local water contents integrated over the two-dimensional volume of the system. . .L**3/L.
QTHM	Same as QTH, but for element M. . .L**3/L.
QTHP	Same as QTH, but for previous time step. . .L**3/L.
R(NP)	Load vector for current time step. . .L**3/L/T.
RES	Maximum residual for all nodes. . .L.

RESNP	Residual at node NP, i.e., difference between current pressure and pressure at the previous interate. . .L.
RD	Maximum relative residual for all nodes.
RF(I,J)	Array of rainfall-rate interpolation points(J) appropriate for profile I.
RFALL(I)	Rainfall rate for profile I at any given time. . .L/T.
RFNI,RFNJ	Rainfall components normal to the surface at nodes NI and NJ, respectively. . .L/T.
RHO	Density of water. . .M/L**3.
RP(NP)	Array for storage of constant Neumann boundary conditions. . .L**3/L/T.
RQ(IQ)	Load vector for element M. . .L**2/T.
RSFLX(NPP)	Boundary flow of rainfall-seepage node NPP. . .L**3/L/T.
S(KQ),SS	Local X-coordinates.
SNFE,SINFE	Sine of angle FE.
SUBHD(I,J)	Array of subheadings for output clarification.
T(KQ),TT	Local Z-coordinate.
TFLOW(I)	Total of the quantities FLOW(I) over all time increments. . .L**3/L.
TH(M,IQ)	Moisture content at the nodes of each element. . .L**3/L**3.
THPAR	Data array for storing table heading for output of TH parameters where TH is moisture content.
THPROP(MTYP,I)	Moisture content (TH) parameters where MTYP is the material type and I is the specific parameter.
THQ(IQ)	Water content at the four corner nodes of element M. . .L**3/L**3.
THQP	Water content at Gauss-integration point. . .L**3/L**3.
TIME	Total time of simulation. . .T.
TITLE	Array for title of the problem.

TMAX	Maximum value of simulation time. . .T.
TOLA	Tolerance for steady-state iterations. . .L.
TOLB	Tolerance for transient-state iterations. . .L.
TRF(I,J)	Array of interpolation times J appropriate for rainfall profile I. . .T.
U(IQ)	Derivative of interpolation function with respect to Z at the Gauss integration points. . .L**(-1).
V(IQ)	Derivative of interpolation function with respect to X at the Gauss integration points. . .L**(-1).
VISC	Viscosity of water. . .M/L/T.
VNNI,VNNJ	Components of the Darcy velocity normal to the surface at nodes NI and NJ, respectively. . .L/T.
VX	X-component of velocity. . .L/T.
VZ	Z-component of velocity. . .L/T.
W,W1,W2	Time-integration parameters.
X(NP),Z(NP)	X- and Z-coordinates of node NP. . .L.
XO,ZO	Fake coordinates used to determine the signs of the direction cosines. . .L.
XQ(IQ),ZQ(IQ)	Coordinates of the nodes of a quadrilateral element. . .L.

APPENDIX E

DATA INPUT GUIDE

1. Title: Format (I5,9A8). One card per problem.

NRPOB	TITLE
5	77

2. Basic integer parameters: Format (16I5). One card per problem.

NNP	NEL	NMAT	NCM	NTI	KSS	KSP	NSPPM	KSTR	KCP	KGRAV	NSTRT	MAXIT	MAXCY
5	10	15	20	25	30	35	40	45	50	55	60	65	70

3. Basic real parameters: Format (8F10.0). Two cards per problem. Use of an E-, D-, or another F-type field specification in the input card overrides any of the F10.0 specifications of the format.

DELT	CHNG	DELMAX	TMAX	FE	TOLA	TOLB	RHO
			40	50	60	70	80

GRAV	VISC	W
10	20	30

4. Printer output control: Format (80I1). The number of cards here depends on the number of time increments NTI.

KPRO	KPR(1)	KPR(2)	. . .	KPR(NTI)
1	2	3		

5. Material properties: Format (8F10.0). A total of NMAT cards, one for each material.

PROP(1,1)	PROP(1,2)	. . .	PROP(1,NMPPM)
⋮			
PROP(NMAT,1)	PROP(NMAT,2)	. . .	PROP(NMAT,NMPPM)
10	20		

In the variable PROP(I,J), I is the material type and J is the specific material property. For example, PROP(I,1) is ALP(I), PROP(I,2) is BETAP(I), PROP(I,3) is POR(I), PROP(I,4) is KX(I), and PROP(I,NMPPM) is KZ(I). (NMPPM=5 is currently prescribed by a data statement in routine MAIN.)

6. Analytic soil parameters: Format (8F10.0). These cards are input if and only if KSP=0. Two sets of cards per material, one for moisture-content parameters and the other for conductivity (permeability) parameters. The number of cards per set is determined both by the number of soil properties per material NSPPM and by the number of materials NMAT.

THPROP(1,1)	THPROP(1,2)	. . .	THPROP(1,NSPPM)
	⋮		
THPROP(NMAT,1)	THPROP(NMAT,2)	. . .	THPROP(NMAT,NSPPM)

AKPROP(1,1)	KAPROP(1,2)	. . .	AKPROP(1,NSPPM)
	⋮		
AKPROP(NMAT,1)	AKPROP(NMAT,2)	. . .	AKPROP(NMAT,NSPPM)
10	20		

7. Soil properties in tabular form: Format (8F10.0). These cards are input only if KSP≠0. Four sets of cards per material for pressure, water content, conductivity (permeability), and water capacity. The number of cards per set is determined by input parameters NSPPM and NMAT.

HPROP(1,1)	HPROP(1,2)	. . .	HPROP(1,NSPPM)
	⋮		
HPROP(NMAT,1)	HPROP(NMAT,2)	. . .	HPROP(NMAT,NSPPM)
10	20		

THPROP(1,1)	THPROP(1,2)	. . .	THPROP(1,NSPPM)
⋮			
THPROP(NMAT,1)	THPROP(NMAT,2)	. . .	THPROP(NMAT,NSPPM)

AKPROP(1,1)	AKPROP(1,2)	. . .	AKPROP(1,NSPPM)
⋮			
AKPROP(NMAT,1)	AKPROP(NMAT,2)	. . .	AKPROP(NMAT,NSPPM)

CAPROP(1,1)	CAPROP(1,2)	. . .	CAPROP(1,NSPPM)
⋮			
CAPROP(NMAT,1)	CAPROP(NMAT,2)	. . .	CAPROP(NMAT,NSPPM)
10	20		

8. Nodal-point positions: Format (I5,2F10.3). Usually one card per node is needed, i.e., a total of NNP cards. However, if some nodes fall on a straight line and are equidistant, data for only the first and last points of this group are needed. Intermediate nodal positions are automatically generated by linear interpolation.

NJ	X(NJ)	Z(NJ)
5	15	25

⋮

9. Element definitions: Format (16I5). Usually one card per element is needed, i.e., a total of NEL cards.

MI	IE(MI,1)	. . .	IE(MI,5)	MODL	NLAY
5	10		25 30	35	40

⋮

IE(MI,1)-(IEMI,4) are the nodal numbers of element MI (beginning with the lower left and progressing around the element in a counterclockwise direction), and IE(MI,5) is the material type MTYP. For rectangular blocks of elements--the same material having sequentially numbered nodes--it is only necessary to specify the first element, the width MODL, and the length NLAY, where MODL and NLAY are measured in elements. Element numbering proceeds most rapidly along the MODL dimension and least rapidly along the NLAY dimension. Figure E.1 provides an example. The object is considered

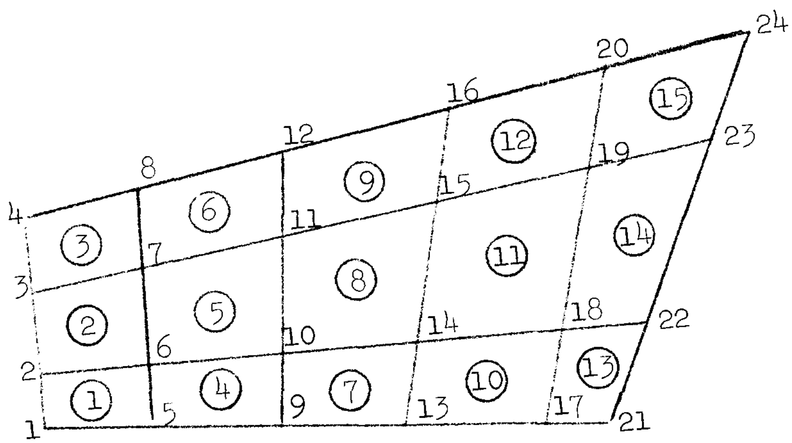


Fig. E.1. Automatic generation of element numbers. Element numbers are circled to distinguish them from nodal numbers.

to be rectangular since it has width MODL=3 on two opposite sides and length NLAY=5 on the other two sides. To generate definitions of elements 2 through 15 automatically, including both corner node identification and material type, only one card is necessary:

1	1	5	6	2	1	3	5
5	10	15	20	25	30	35	40

Although all elements of this example will be assumed to contain the same material, MTYP=1, this situation can easily be changed by using the correction-material facility.

10. Material correction: Format (16I5). In many cases one card is required per material change. However, in those cases where numbers of the affected elements range from a lower limit of MI to an upper limit of MK with an increment MINC, automatic correction may be used. Fields MK and MINC are left blank if the automatic-generation facility is not used.

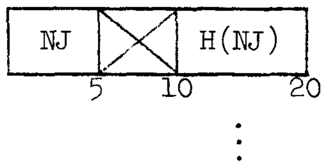
MI	MTYP	MK	MINC
5	10	15	20

⋮

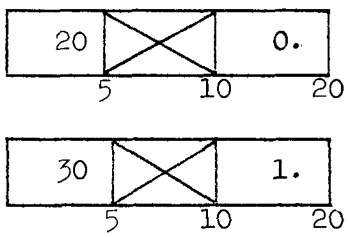
Note on initial conditions and restarting: The initial condition for a transient calculation may be obtained in three different ways: from card input, auxiliary storage input (referred to as tape input in discussion to follow), or steady-state calculation using a different set of boundary conditions than that used for transient calculation. In the latter case a card input of, shall we say, the preinitial condition is required as the zeroth-order iterate of the steady-state solution. Tape input is necessary whenever the restarting facility is being used. That is, pressure distributions for NSTRT, or more, different times have been generated and written on a magnetic tape. If NSTRT>0, these distributions will be read from the tape, and the NSTRT-th distribution will be used as the initial condition for the current calculation. (If KSTR>0, the pressure values will be written on a different magnetic tape as they are being read so that a complete record of the calculations may be kept on one tape.). If either the first (card-input) or the last (steady-state) options are desired, then NSTRT=0.

Note on auxiliary storage units: Logical unit 1 is used for output if KSTR≠0, and logical unit 2 is used for input if NSTRT>0. Proper identification of these units must be made in the job control language if either of these two options is used.

11. Card input for initial or preinitial conditions: Format (I5,5X,F10.0). These cards are necessary only if NSTRT=0. In the most general case there is one card per node, i.e., a total of NNP cards.



Frequently, however, groups of neighboring nodal points NJ have identical values H(NJ). If a gap is recognized in the input sequence of nodal numbers, the initial pressures are assumed to be identical to the pressure at the lower boundary of the gap. For example, if two neighboring cards of the form



were encountered, nodes 21-29 would be assigned values H=0.

Note on steady-state input: The steady-state option may be used to provide either the final state of a system under study or the initial condition for a transient calculation. In the former case KSS=0 and NTI=0, whereas in the latter KSS=0 and NTI>0. If KSS≠0, there will be no steady-state calculation. Use of a steady state as an initial condition requires a different set of boundary conditions than is used for the transient calculations. (A transient calculation using the same set of boundary conditions would not be meaningful since no changes in the pressure distributions could occur.) Input Data Sets 12-17, immediately following, define the steady-state boundary conditions. They are, of course, necessary if and only if KSS=0.

12. Steady-state integer parameters: Format (16I5). This card is input if and only if KSS=0. One card per problem.

NBC	NST	NRFPR	NRFPAR	NRSEL	NRSN
5	10	15	20	25	30

13. Steady-state rainfall profiles: Format (8F10.0). These cards are necessary if and only if the number of rainfall-seepage nodes NRSN>0 and the number of rainfall profiles NRFPR>0. If NRSN>0 and NRFPR=0, a rainfall rate of zero is assumed. The number of cards required will depend on both NRFPR and NRFPAR, the number of parameters within each profile.

TRF(1,1)	TRF(1,2)	. . .	TRF(1,NRFPAR)

RF(1,1)	RF(1,2)	. . .	RF(1,NRFPAR)

⋮

TRF(NRFPR,1)	TRF(NRFPR,2)	. . .	TRF(NRFPR,NRFPAR)

RF(NRFPR,1)	RF(NRFPR,2)	. . .	RF(NRFPR,NRFPAR)

Only the linearly interpolated value of the rainfall rate RF at time TRF=0 will be used in the steady-state calculation. (See Data Set 19, below.)

14. Steady-state rainfall types and ponding depths: Format (3I5,5X,2F10.0). Card input is required here if and only if NRSN>0. Typically one card is required per rainfall-seepage node as follows:

NI	IRFTYP(NI)	NPINC	╳	HCON(NI)
5	10	15	20	30

⋮

However, if NPINC ≠ 0, this information is automatically generated. If the card immediately preceding is for node NJ, then nodes NJ + NPINC, NJ + 2*NPINC, ..., NK will be given rainfall type IRFTYP(NJ) and puddling depth HCON(NJ), where NK is the largest integer in the above sequence that is less than the current nodal value NI. Rainfall type values IRFTYP(NI) ≥ 0 are permitted. If the value is zero, then a rainfall rate of zero is assumed for node NI. If the value is greater than zero, then IRFTYP(NI) serves as a pointer to a rainfall profile input under Data Set 13 which is to be used to obtain the rainfall rate at node NI.

15. <u>Steady-state rainfall-seepage surface elements</u>: Format (16I5). As in the two previous input sets, input is necessary here if and only if rain falls on surfaces or seepage flows through surfaces, or both, i.e., NRSN>0. Typically, one card is required for each side of each element on which such a boundary is to be applied.

NRSE(MP)	IS(MP,1)	IS(MP,2)	KINC
5	10	15	20

⋮

However, if KINC>0, automatic generation is employed in the following manner. Nodal-point and element number increments are formed from information on the input card immediately preceding the current one:

$$NPINC=IS(MP,2) - IS(MP,1)$$

and

$$MINC = |NPINC| - 1$$

where the vertical bars denote absolute value. A sequence of element numbers is then obtained:

$$M = NRSE(MP) \quad \text{(previous card)}$$

$$NRSE(MP+1) = M + MINC$$

$$NRSE(MP+2) = M + 2*MINC$$

⋮

The sequence is continued until the largest element number is encountered that has a value less than NRSE of the current card. Corresponding nodal point sequences are also generated:

NI = IS(MP,1) (previous card)

IS(MP+1,1) = NI + NPINC

IS(MP+2,1) = NI + 2*NPINC

⋮

and

NJ = IS(MP,2)

IS(MP+1,2) = NJ + NPINC

IS(MP+2,2) = NJ + 2*NPINC

⋮

16. Steady-state Dirichlet pressure-type boundary conditions: Format (2I5,2F10.0). These cards are necessary if and only if NBC>0 (and KSS=0, a condition either stated or implied for the last four sets of cards). If automatic generation is not used (NPINC=0), NBC cards are required of the form:

NN(NPP)	NPINC	BB(NPP)
5	10	20

⋮

If NPINC>0, automatic generation proceeds in the same manner as described for Data Set 14. That is, an algebraic sequence is built on the nodal number NN of the card immediately preceding, and each such node is given boundary condition BB of that card.

17. Steady-state Neumann flux-type boundary conditions: Format (3I5, 5X,2F10.0). Cards of this type must be used if and only if NST > 0 Usually a number of cards equal to NST must be used. However, if

some of the KINC are greater than zero, some of the NST boundary conditions will be generated internally, and NST cards will not be necessary.

NI	NJ	KINC		EI	EJ
5	10	15	20	30	40

⋮

If KINC>0, then the nodal-point increment is formed from NI and NJ of the immediately preceding card:

$$NPINC = |NJ - NI|$$

Two sequences are formed:

NI + NPINC, NI + 2*NPINC . . .
NJ + NPINC, NJ + 2*NPINC . . .

Both are terminated when the largest integer is reached that is less than both current values of NI and NJ. Corresponding nodal points for these two sequences define a surface. Quantity EI is the dot product of the flux at NI with an outwardly directed unit vector normal to the element side (NI,NJ). A similar definition holds for EJ.

Note on transient-state input: Data Sets 18-23 which follow are identical to sets 12-17, which are used to define the boundary conditions for the steady-state calculation. Most of the remarks regarding automatic generation, sign conventions, and other input restrictions that are pertinent there are pertinent here as well. Cards, whose descriptions follow, are necessary only if NTI>0. If NIT=0, there will be no transient calculation, and transient-state boundary conditions are unnecessary.

18. Transient-state integer parameters: Format (16I5). One card per problem.

NBC	NST	NRFPR	NRFPAR	NRSEL	NRSN
5	10	15	20	25	30

19. Transient-state rainfall profiles: Format (8F10.0). These cards are necessary if and only if the number of rainfall seepage nodes NRSN>0 and the number of rainfall profiles NRFPR>0.

TRF(1,L)	TRF(1,2)	. . .	TRF(1,NRFPAR)
RF(1,1)	RF(1,2)	. . .	RF(1,NRFPAR)
		⋮	
TRF(NRFPR,1)	TRF(NRFPR,2)	. . .	TRF(NRFPR,NRFPAR)
RF(NRFPR,1)	RF(NRFPR,2)	. . .	RF(NRFPR,NRFPAR)

This input provides the basic data for a linear interpolation from which the rainfall rate RF may be obtained at any time TRF and at any boundary node, as specified by pointer indices IRFTYP.

20. Transient-state rainfall types and ponding depth: Format (3I5, 5X,2F10.0). Card input is required here if and only if NRSN>0.

NI	IRFTYP(NI)	NPINC	X	HCON(NI)
5	10	15	20	30

⋮

21. Transient-state rainfall-seepage surface elements: Format (16I5).

Input is required if and only if NRSN>0.

NRSE(MP)	IS(MP,1)	IS(MP,2)	KINC
5	10	15	20

⋮

22. Transient-state Dirichlet pressure-type boundary conditions:

Format (2I5,2F10.0). These cards are necessary if and only if

NBC>0.

NN(NPP)	NPINC	BB(NPP)
5	10	20

⋮

23. Transient-state Neumann flux-type boundary conditions: Format

(3I5,2F10.0). Cards of this type must be used if and only if

NST>0.

NI	NJ	KINC	X	EI	EJ
5	10	15	20	30	40

⋮

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