THREE-DIMENSIONAL FINITE ELEMENT
MODELING OF POLLUTANT
TRANSPORT IN AQUIFERS

By

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CHAPTER I

INTRODUCTION

The use of aquifers as a source of freshwater to supply public need has increased. Requirements of the Environmental Impact Analysis and Statement have focused public attention on the quality of water for domestic use. Factors which affect the groundwater quality include: (a) leakage from ponds and lagoons, (b) sanitary landfills, (c) deep injection wells, (d) road salt, pesticides and fertilizers, (e) sanitary landfills, (f) sea water intrusion, (g) mine drainage and oil-field brines, (h) cesspools and septic tanks, (i) leakage from oil pipeline oil storage tanks and sewage pipelines, (j) animal feed lots, and (k) industrial waste water. Numerical modeling seems to be the best tool for understanding, preventing, and predicting the groundwater problems.

Research Problem

In this study, Galerkin's finite element method is used to analyze the transport of a pollutant in a three-dimensional aquifer system. The collection of water quality data is expensive and gathering information on migration of contaminant plumes under field conditions is a lengthy process; therefore, a properly calibrated and validated numerical model used with field data is an excellent tool with which to predict the future migration of a plume in saturated aquifers.

Objectives

(1) To develop Galerkin's finite element method for solving the three-dimensional solute transport in a saturated aquifer;

(2) To validate the model using the existing analytical solutions of the dispersion equation in two and three dimensions;

(3) To validate the model with available numerical models in two dimensions.

Procedures

Galerkin's finite element method is modeled with the solute transport equation. The model requires that the continuous variables be replaced with discrete variables as elements. Each discrete subregion is modeled by the same transport equation. The concentration will be assembled at all nodes and solved on an IBM 3081K system. After the model is developed, it is validated against existing analytical solutions.

CHAPTER II

LITERATURE REVIEW

Ground water represents more than 95 percent of all available freshwater in the world. Total groundwater withdrawal of 89 bgpd provides 20 percent of the water used in the United States. Approximately 34 percent of the public water supply and 79 percent of the water for rural domestic use are derived from potable groundwater sources. Groundwater is an important natural resource that can become increasingly valuable throughout the country. The increased use of groundwater as a source of potable water will depend on controlling its contamination. Mathematical modeling can be used as an effective tool in the development of methods for abating groundwater pollution.

The development of advanced computer techniques have enabled engineers to use a discrete process for approximating complex problems. The partial differential equations are divided into a set of discrete equations, which in turn are reduced to a system of algebraic equations. Two major techniques have been used in the groundwater field. One is the finite difference method and the other one is the finite element method. In recent years, several textbooks have been published that are excellent for studying these two methods. They are: Remson, Hornberger, and Molz (1971), Segerlind (1976), Pinder and Gray (1977), Rao (1982), and Zienkiewicz and Morgan (1983). In this chapter, a detailed discussion of these two methods will be given.

Finite Difference Method (FDM)

The finite difference method (FDM) is a discrete technique in which the domain of interest is represented by a set of points or nodes, and information between these points is commonly obtained using Taylor's series expansions. Richardson (1910) introduced the finite difference method to calculate the approximate solution of partial differential equations.

Solving the solute transport problem, one calculates the groundwater flow velocities. Prickett (1975) summarized the numerical and analog models in his reports. Douglas, Peaceman, and Rachford (1959) used an Alternating Direction Implicit (ADI) technique to solve a two dimensional, two phase, incompressible flow model. Peaceman and Rachford (1962) used a similar method to solve the problem of miscible displacement in porous media. Bresler (1973) and Marino (1974) used the Crank-Nicholson technique to obtain solutions solving the mass transport problems. The finite difference method of solving the mass transport equations may introduce numerical dispersion. Numerical smearing and artificial dispersion of a sharp concentration front were shown to be at least of the same order of magnitude as the actual dispersion. This artificial dispersion limits the applicability of the solutions. Lantz (1971) and Chaudhari (1971) provide guidelines for a high order finite difference scheme that eliminates most of the numerical dispersion.

Garder, Peaceman, and Pozzi (1964) used the method of characteristics (MOC) to solve a one dimensional dispersion equation. Reddell and Sunada (1970) used the method to solve the problem of saltwater intrusion. Pinder and Cooper (1970) used the ADI procedure to solve the flow equation and the MOC to solve the solute transport equation. Konikow and Bredehoeft (1978) developed a MOC model to study changes in dissolved solid concentration in a stream-aquifer system. Numerical solutions of the dispersion equation for different adsorption equilibrium were provided by Lai and Jurinak (1972) using the explicit finite-difference scheme. Douglas and Jones (1963) developed a technique called the Predictor-Corrector Finite Difference Method. The method uses two finite approximate differences, each advancing the solution by one-half increment in the time domain. The predictor equation is a modification of the implicit finite-difference approximation, and the corrector equation is a modification of the Crank-Nicholson approximation (Remson et al. 1971). Tagamets and Sternberg (1974) used the method for solving the one dimensional convection-dispersion equation for adsorption in porous media. Trescott, Pinder, and Larson (1975) solved the two-dimensional flow problem by the Line

Successive Over Relaxation (LSOR) method and compared it with the ADI method.

The explicit approximation is sometimes referred to as a "Forward Difference," and the implicit approximation is referred to as a "Backward Difference." Pinder and Gray (1976) described the explicit method as requiring a minimum of computational effort, but usually conditionally stable. The implicit method is usually unconditionally stable yet it requires an additional computational effort when a variable time step is used. The Crank-Nicholson method is second order accurate and usually stable.

Finite Element Method (FEM)

The finite element method is numerical method that can be used to solve complex engineering problems.

Clough (1960) appears to be the first to use the term "finite element." Today, the finite element method is a powerful tool for the approximate solution of differential equations governing diverse physical phenomena. The method can be seen as a discretization procedure of continuum problems presented by mathematically defined statements. High speed electronic digital computers have enabled engineers to employ various numerical discretization techniques for approximating solutions of complex problems. The finite element method was originally developed as a tool for structural analysis, but the theory and formulation have been progressively refined and generalized so that the method can be applied successfully to other fields such as heat flow, seepage, etc.

The two major approaches are (a) the Variational Approach and (b) the Weighted Residual Approach.

Variational Approach (Raleigh-Ritz Method)

The variational approach applies the calculus of variations. Variational calculus states that the minimization of the functional requires that the differential equation, with the boundary conditions, be satisfied. The variational approach can be used with most physical and engineering problems.

Weighted Residual Approach

In the weighted residual approach, the finite element matrices are derived directly from the governing differential equation. These equations satisfy both the homogeneous and certain specific boundary conditions. In several investigations, the method has been used to solve the groundwater flow and quality problems.

In the method of weighted residuals, the function C is replaced by trial function $\overline{C}$. $\overline{C}$ is a set of approximation close to C,

$$C \cong \overline{C} \cong \sum_{i=0}^{n} C_i W_i \qquad i = 0, 1, 2, \ldots n \tag{2.1}$$

where C is a linear independent function, W_i is the weighting function defined over both the time and space domain. C_i indicates undetermined coefficients. The approximate function $\overline{C}$ is substituted into the governing equation, resulting in an error called the residual.

$$L(C) = L(\overline{C}) = R \tag{2.2}$$

This method chooses the undetermined coefficients such that the error can be minimized to zero, thus making the trial solution equal to the exact solution.

The function L(R) is chosen so that L(R) = 0 when R = 0, W_j is the weighting function, j = 1,2,...n and the integration is over the domain of the problem. The equation can be shown as:

$$\int_t \int_V L(R)\ W_j\ dV\ dt = 0 \tag{2.3}$$

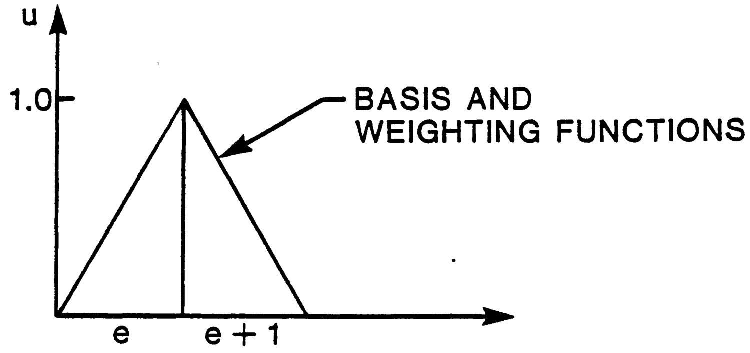
Three different weighted residual methods are described as follows (Figure 1).

(a) Galerkin's Method:

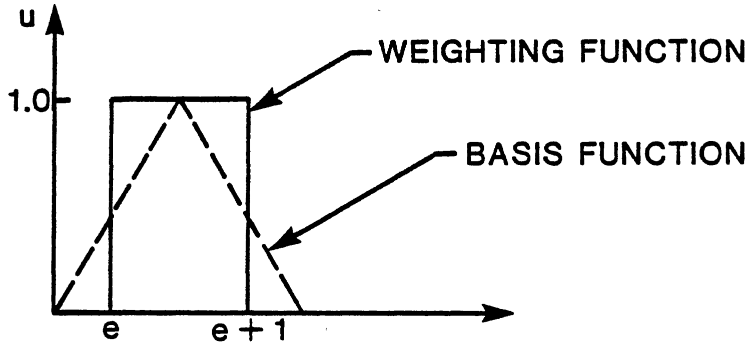
The Galerkin's method chooses the basis function to be the same as the weighting function yielding

$$\int_V R\ W_j\ dV = 0 \quad j = 1,\ 2, \ldots n \tag{2.4}$$

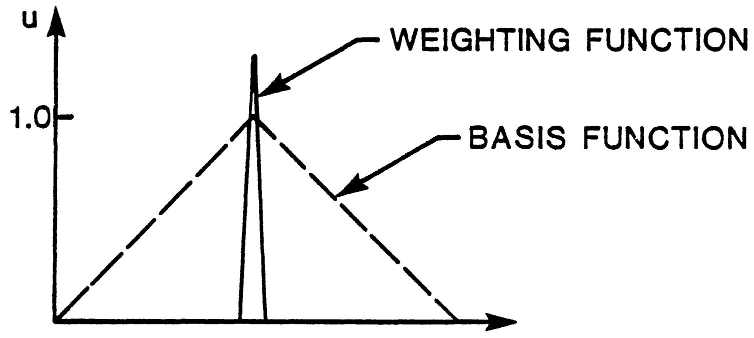
The requirement of this method is that the continuous function must be zero if it is orthogonal to every member of the complete set.



(a) GALERKIN METHOD



(b) SUBDOMAIN METHOD



(c) COLLOCATION METHOD

Figure 1. The Three Weighted Residual Methods

(b) Subdomain Method:

In the subdomain method, the domain V is first divided into finite subdomains. Unity is chosen as the weighting function in the subregion V_i and zero is used elsewhere so that

$$\int_V R\, W_j\, dV = 0 \tag{2.5}$$

where $W_j = 1$ if (x,y,z) in domain V_i otherwise $W_j = 0$.

(c) Collocation Method:

In the collocation method, Dirac delta is chosen as the weighting function W_j.

$$W_j = \delta(x-x_i)\delta(y-y_i)\delta(z-z_i) \tag{2.6}$$

The method approaches the exact solution by setting the residue equal to zero at n points in domain V,

$$\int_V R\delta_i(x,y,z)\, dV = 0 \quad i = 1,2,\ldots n \tag{2.7}$$

FEM-Solute Transport

The application of the finite element models to groundwater began in the 1960's (Zienkiewicz, Mayer, and Cheung, 1966). Witherspoon and Javendel (1968) applied the finite element method to transient flow in porous media by employing the variational principle. Price, Carendish, and Varga (1968) introduced a numerical method of high order accuracy for the one-dimensional diffusion-convection equation based on Galerkin's approach. Guymon (1970) and Guymon, Scott, and Harrmann (1970) presented a variational approach to the dispersion equation in which the convective terms do not appear explicitly. Nalluswami, Logenbaugh, and Sunda (1972) expanded Guymon's work by improving the numerical techniques, taking into account the tensor properties of the dispersive coefficient. Tyagi (1971, 1973, 1975a, 1975b, 1975c) used the finite element method to predict the transition zone between fresh and salt water in coastal aquifers, the flow in saturated and unsaturated zones of aquifers, and the water quality in unsaturated flows. Bruch and Zyvoloski (1973) used a finite element weight residual solution in a one-dimensional diffusion-convection field problem. The results are compared with a finite-difference solution as well as the analytical solution. Pinder (1973) used Galerkin's finite element approach to simulate the areal movement of a saturated aquifer. Cheung and Harrison (1973) applied the finite element methods to two-dimensional field problems in isotropic media. Smith, Farraday, and O'Connor (1973) used Raleigh-Ritz and Galerkin's finite element methods to solve the two-dimensional diffusion-convection problem, taking into consideration the miscible displacement. Sykes (1975) developed a two-dimensional model for variably saturated porous media that was used to predict the transient movement of the trace redionuclide and to analyze the transport of ammonium undergoing nitrification and denitrification. He applied Galerkin's technique to the mass conservation equation. Gupta and Tanji (1975) developed a three-dimensional flow and mass transport model. The model was applied to a complex groundwater region in Sutter Basin, California, to simulate the rising connate water through a vertical fault. In the various situations where high-speed computers can simulate complex water systems at a minimum cost, models have been developed. Wang and Cheng (1975) studied the two-dimensional convection-dispersion equation to solve the pollutant dispersion in a semi-infinite aquifer.

A two-dimensional transient model for the flow of a dissolved constituent throughout porous media was developed by Duguid and Reeves (1976). The mechanism of adjective transport, hydrodynamic dispersion, chemical adsorption, and radioactive decay are included in the mathematical formulation. The model also simulates a pond seepage problem, Grove (1977) used Galerkin's finite element method to solve mass-transport equations. The technique was applied to a field problem involving an aquifer polluted with chloride, tritium, and strontium-90. The results, compared with the finite difference method and the analytical solution, showed a high degree of accuracy. Van Genuchten (1978) developed a model for predicting potential groundwater pollution by the disposal of liquid or solid waste. A hypothetical landfill located adjacent to a river provided considerable insight into the subsurface movement of landfill leachates. Gureghian, Ward, and Cleary (1980, 1981) developed a two-dimensional model for the migration of the groundwater pollutant. A field application of the model was made to the leachate migration from the Babylon sanitary landfill in Long Island, New York. The results were compared with those of a two-dimensional analytical solution. The results were in agreement during the calibration and verification period.

The numerical model used to simulate the groundwater contamination from Price's landfill in New Jersey was presented by Gray and Hoffman (1983), and was a two-dimensional transient model using linear triangular elements. The model assumed that the species being considered was convective and nonabsorbing.

Gupta, Kincaid, Meyer, Newbill, and Cole (1982) developed a multi-dimensional finite element code for the analysis of coupled fluid, energy and solute transport. A major thrust of this program has been the study of natural aquifers as host for thermal energy storage and retrieval.

Voss (1984) developed a computer program that simulates fluid movement and the transport of either energy or dissolute substances in a subsurface environment.

Cole, Gupta, and Pinder (1984) developed a three-dimensional groundwater model for a multiaquifer system in which isoparametric element is used. The model was applied to a groundwater reservoir beneath Long Island, New York. Babu and Pinder (1984) developed a model based on an operator splitting algorithm which treats the horizontal plane using finite elements in the first step, and the vertical dimension using finite difference in the second step. The model provides considerable saving in both computer memory requirements and computational efforts.

Comparison of FEM and FDM

(a) In finite difference approximations of a differential equation, the discrete representation of the equation is applied at a point. In the finite element method the discrete equations are applicable over a region.

(b) The numerical solution of the dispersion equation may cause numerical dispersion. The algebraic equations generated by the finite difference method are particularly susceptible to numerical errors, while finite element method solutions, in general, are more reliable (Anderson 1979).

Benefits of Using the Finite Element Method

(a) With the finite element method, the domain of interest can be divided into irregular subdivisions, as described by the physical geometry of the problem.

(b) The properties of each element can be evaluated individually. Each element can be linked to different material properties.

(c) The boundary conditions can be adjusted easily.

(d) The method is flexible and can be used to handle thermal energy, chemical loads, time dependence, and nonlinearities.

CHAPTER III

MATHEMATICAL FORMULATION

This chapter presents a basic equation of groundwater flow and solute transport in porous media. The mathematical derivation of both equations has been documented by Jacob (1940), Cooper (1966), Remson et al. (1971), Bear (1972, 1977), Ogata (1974), Grove (1978), and Mercer and Faust (1980). In this study, our interest is in the flow and solute transport in saturated zones of aquifers.

Flow Equation

An equation that describes a three-dimensional unsteady groundwater flow can be written as:

$$\frac{\partial}{\partial x}\left(k_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_{yy}\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_{zz}\frac{\partial h}{\partial z}\right) + Q = S_s\frac{\partial h}{\partial t} \qquad (3.1)$$

where h = hydraulic head, (L),

k_{ii} = hydraulic conductivity, $i = x, y, z$, (L/T),

Q = source of sink term, (L/T), such as irrigation, wells, and evapotranspiration,

S_s = specific storage, (L^{-1}),

t = time, (T).

For the homogeneous fluid with a saturated aquifer with thickness b (L), the transmissivity of the aquifer may be defined as $T_{ii} = k_{ii}b$, where T_{ii} is the transmissivity (L^2T^{-1}). The storage coefficient of the aquifer can be defined as $S = S_s b$, where S is the storage coefficient (dimensionless).

Assuming that the Cartesian coordinates axes x and y are aligned with the principal components of the transmissivity tensor, the three-dimensional saturated flow can be represented as:

$$\frac{\partial}{\partial x}\left(T_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(T_{yy}\frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(T_{zz}\frac{\partial h}{\partial z}\right) + Q_b = S_s\frac{\partial h}{\partial t} \qquad (3.2)$$

where Q_b is the volume flux per unit area (LT^{-1}).

For a two-dimensional groundwater flow, the equation may be written as:

$$\frac{\partial}{\partial x}\left(T_{xx}\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(T_{yy}\frac{\partial h}{\partial y}\right) = S_s\frac{\partial h}{\partial t} - Q_b \qquad (3.3)$$

The Groundwater Flow Equation

The problem of nonsteady flow in an artesian aquifer was first analyzed by Theis (1935). Jacob (1940) applied the Theis equation with hydrologic concepts and derived a differential equation for nonsteady flow in a uniformly thick, horizontal, compressible sand. The equation stated in two dimensions is:

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = \frac{S}{T}\frac{\partial h}{\partial t} \qquad (3.4)$$

$S = \rho g b(\alpha_p + \Theta\beta_p)$,

T = transmissivity of the medium, L^2T^{-1},

b = thickness of aquifer, L,

S = storage coefficient (dimensionless),

α_p = compressibility of medium LT,

β_p = compressibility of liquid, LT^2M^{-1},

Θ = porosity of the medium.

The equation can be extended to a three-dimensional saturated flow and expressed as:

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} + \frac{\partial^2 h}{\partial z^2} = \frac{S_s}{k}\frac{\partial h}{\partial t} \qquad (3.5)$$

The basic governing equation for saturated flow is

$$\frac{\partial}{\partial x}\left(k_x \frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_z \frac{\partial h}{\partial z}\right) - Q = S\frac{\partial h}{\partial t} \qquad (3.6)$$

where Q = strength of sink or source, LT^{-1};

$Q = Q_w(x_i, y_i, z_i, t)\delta(x-x_i)(y-y_i)\delta(z-z_i)$

where Q_w = well discharge or recharge, L^3T^{-1};

δ = Dirac delta function.

There are several books that give a detailed derivation of the groundwater flow equation in saturated porous media, three of which are Bear (1972, 1979) and Remson et al. (1971).

To apply the principle of conservation of mass to a control volume (representative element volume), we first consider the y-z plane. The rate of solute into the plane at x is $CV^*_{x,x}dydz$ and the rate of solute flow out y-z face at x+dx is $CV^*_{x+dx}dydz$. Similar expression is used for the other two planes (Figure 2).

The mass balance is

$$\text{INPUT - OUTPUT = ACCUMULATION} \tag{3.7}$$

so,

$$\begin{aligned} &(CV^*_{x,x} - CV^*_{x,x+dx})\ dydz \\ &(CV^*_{y,y} - CV^*_{y,y+dy})\ dydz \\ &(CV^*_{z,z} - CV^*_{z,z+dz})\ dydz \end{aligned} \tag{3.8}$$

$$dxdydz\frac{\partial C}{\partial t} = -(\partial CV_{dx}dydz) + (-\partial CV_{dy}dxdz) + (-\partial CV_{dz}dxdy) \tag{3.9}$$

Divide by dxdydz:

$$\frac{\partial C}{\partial t} = \frac{\partial CV^*}{\partial x} + \frac{\partial CV^*}{\partial y} + \frac{\partial CV^*}{\partial z} \tag{3.10}$$

The rate of solute accumulation within the volume element is $\partial c/\partial t dxdydz$. Bear (1972, 1977) gave the equation for calculating the velocities:

$$CV^*_i = CV_i + CV^o \tag{3.11}$$

where $V_i = V^* - V_i$,

V^*_i = mass of average velocity

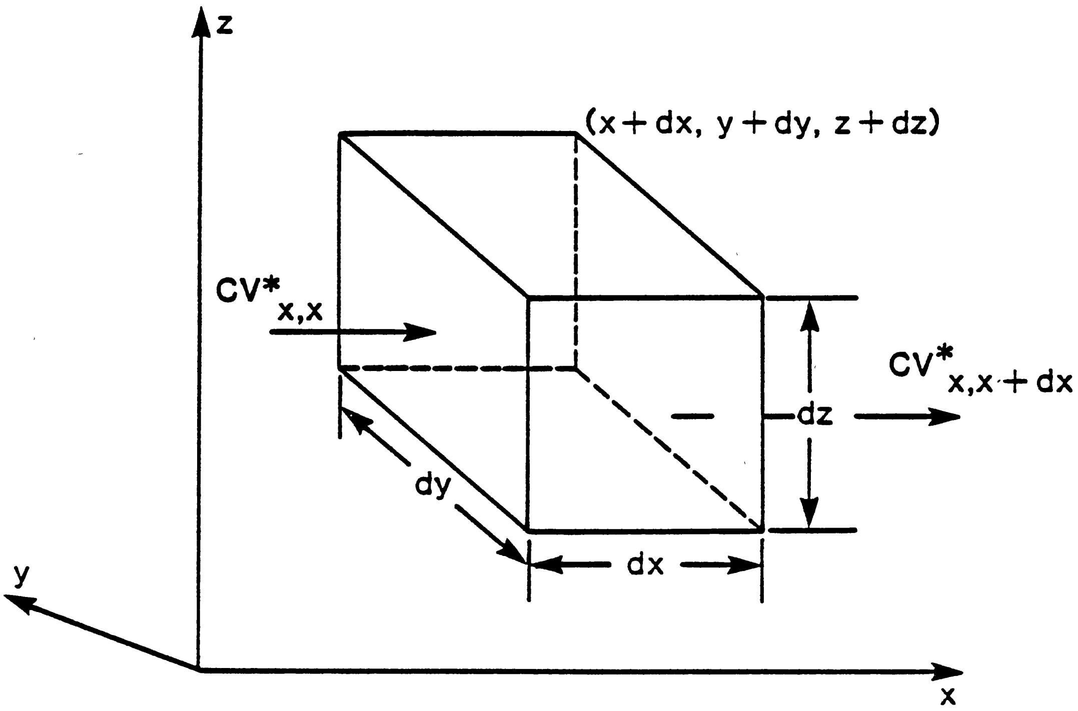


Figure 2. Control Volume (the Solute Flow Through)

V_i = seepage velocity

V^o = the derivation of the particles instantaneous velocity from the average one

CV_i^* = transport by convection

CV^o = the diffusive flux

D_{ij} = dispersion coefficient

Where we rearrange equation (3.10), the general form of solute transport equation is obtained:

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x_i}\left(D_{ij}\frac{\partial C}{\partial x_j} - V_i C\right) \qquad (3.12)$$

Dispersivity

Scheidegger (1961) and Bear (1972, 1979) stated that the influence of the void space is represented by a_{ijkm}, the dispersivity of the porous medium, which in saturated flow is a property of the geometry of the solid matrix. It is a fourth rank tensor which has certain properties of symmetry. For an isotropic porous medium with two constants:

$$\begin{aligned} a_L &= \text{longitudinal dispersivity} \\ a_T &= \text{transverse dispersivity} \end{aligned} \qquad (3.13)$$

For a three dimensional case: i, j = 1, 2, 3

$$\begin{aligned} a_{iiii} &= a_L \\ a_{iijj} &= a_T \\ a_{iiij} &= a_{iiji} = a_{ijii} = a_{ijjj} = 0 \\ a_{ijij} &= a_{ijji} = 0.5(a_L - a_T) \end{aligned} \qquad (3.14)$$

Several approaches are used to receive the dispersivity. One method is a trial and error adjustment of the value of the chosen longitudinal and transverse dispersivity in a solute transport model of a field situation until the simulated movement pattern closely resembles the pattern observed in the field. Grove and Boetem (1971) described a two-well injection method in which the mathematical equations used to calculate dispersivity from the test are based on the assumption of homogeneity of the geologic materials in the test area. The regional flow can be neglected during the test.

Matthess (1982) stated that the coefficient of hydrodynamic dispersion increases with increasing porosity, growing grain sizes, and growing inconformity. Finally, the hydrodynamic coefficient D depends on groundwater flow velocity.

$$D = \alpha V_W^{(a)+b} \tag{3.15}$$

where D = coefficient of hydrodynamic dispersion

V_W = average groundwater velocity

α = dispersivity coefficient

Matthess and Pekdeger (1981) found that in a laboratory study the value α was on the order of 0.1 cm to 1 m; in field experiments the values were between 0.1 to 100 m; and the values for fractured and karstic rocks were between 10 to 10000 m. The exponent (a) in the equation is close to one.

Dispersion Coefficient

The dispersion phenomenon includes two processes: mechanical dispersion and molecular diffusion. Mechanical dispersion, or spreading the solute with respect to the average flow produced by velocity variation in the pore space, is sometimes called convective diffusion. Molecular diffusion depends on time. Its effects on the overall dispersion are more significant at low flow velocities. In pollutant movement in groundwater, the contribution of molecular diffusion to the hydrodynamic dispersion term is usually negligible in comparison to mechanical dispersion. Scheidegger (1961) and Bear (1972, 1979) pointed out that the dispersion coefficient as a tensor should have 81 components for the three-dimensional case, but they were able, through the use of symmetry, to reduce this number to 32 individual components. For an isotropic medium, they reduced the number of components of the tensor to nine. For the three-dimensional case,

$$D_{ij} = \begin{vmatrix} D_{11} & D_{12} & D_{13} \\ D_{21} & D_{22} & D_{23} \\ D_{31} & D_{32} & D_{33} \end{vmatrix} \qquad (3.16)$$

Bruch and Street (1967) used the following equations to measure the longitudinal and transverse dispersion coefficient.

and
$$D_L = \mu(1.8)(Vd_{50}/\mu)^{1.2}$$
$$D_T = \mu(0.11)(Vd_{50}/\mu)^{0.7} \qquad (3.17)$$

where μ = kinematic viscosity

d_{50} = mean grain size

V = velocity

$R_e < 10^{-3}$

The most popular method of calculating the dispersion coefficient has been described by Scheidegger (1961). Several other investigations give more information about the equation (Bear, 1972; Grove and Boetem, 1971; and Konikow and Bredehoeft, 1978) They show the relationship between the dispersion coefficient and flow velocity as.

$$D_{ij} = a_{ijmn} \frac{V_m V_n}{|V|} \qquad (3.18)$$

where V_m, V_n = a component of the flow velocity of fluid in m and n directions (LT^{-1})

V = the magnitude of the velocity vector (LT^{-1})

For the three-dimensional dispersion coefficient that equals

$$D_{11} = a_{1111} \frac{V_1 V_1}{|V|} + a_{1122} \frac{V_2 V_2}{|V|} + a_{1133} \frac{V_3 V_3}{|V|}$$

$$D_{22} = a_{2211} \frac{V_1 \; V_1}{|V|} + a_{2222} \frac{V^2 \; V_2}{|V|} + a_{2233} \frac{V_3 \; V_3}{|V|}$$

$$D_{33} = a_{3311} \frac{V_1 \; V_1}{|V|} + a_{3322} \frac{V_2 \; V_2}{|V|} + a_{3333} \frac{V_3 \; V_3}{|V|}$$

(3.19)

$$D_{12} = D_{21} = a_{1212} \frac{V_1 \; V_2}{|V|} + a_{1221} \frac{V_2 \; V_1}{|V|}$$

$$D_{13} = D_{31} = a_{1313} \frac{V_1 \; V_3}{|V|} + a_{1331} \frac{V_3 \; V_1}{|V|}$$

$$D_{23} = D_{32} = a_{2323} \frac{V_2 \; V_3}{|V|} + a_{2332} \frac{V_3 \; V_2}{|V|}$$

If we substitute the equation by using isotropic media, it becomes

$$D_{11} = a_L \frac{V_1 \; V_1}{|V|} + a_T \frac{V_2 \; V_2}{|V|} + a_T \frac{V_3 \; V_3}{|V|}$$

$$D_{22} = a_T \frac{V_1 \; V_1}{|V|} + a_L \frac{V_2 \; V_2}{|V|} + a_T \frac{V_3 \; V_3}{|V|}$$

$$D_{33} = a_T \frac{V_1 \; V_1}{|V|} + a_T \frac{V_2 \; V_2}{|V|} + a_L \frac{V_3 \; V_3}{|V|}$$

and

$$D_{12} = D_{21} = (a_L - a_T) \frac{V_1 \; V_2}{|V|}$$

$$D_{12} = D_{31} = (a_L - a_T) \frac{V_1 V_3}{|V|}$$

$$D_{23} = D_{32} = (a_L - a_T) \frac{V_2 V_3}{|V|} \qquad (3.20)$$

Scheidegger (1961) and Bachmat and Bear (1964) also show that for a Cartesian coordinate system x_i in which one of the axes, say x_1, coincides with the direction of the average velocity, then $V_1 = |V|$ and $V_2 = 0$. Substituting these relations into equations, we obtain

$$\begin{aligned} D_{11} &= a_L V = D_L \\ D_{22} &= D_{33} = a_T V = D_T \qquad (3.21) \\ D_{12} &= D_{13} = D_{13} = D_{31} = D_{23} = D_{32} = 0 \end{aligned}$$

Solving quotients equations for a_L and a_T results in

$$a_L = \frac{D_L}{|V|}$$

and

$$a_T = \frac{D_T}{|V|}$$

Introducing quotients produces:

$$D_{11} = D_L \frac{(V_1)^2}{|V|^2} + D_T \frac{(V_2)^2}{|V|^2} + D_T \frac{(V_3)^2}{|V|^2}$$

$$D_{22} = D_T \frac{(V_1)^2}{|V|^2} + D_L \frac{(V_2)^2}{|V|^2} + D_T \frac{(V^3)^2}{|V|^2}$$

$$D_{33} = D_T \frac{(V_1)^2}{|V|^2} + D_T \frac{(V^2)_2}{|V|^2} + D_L \frac{(V_3)^2}{|V|^2}$$

$$D_{12} = D_{21} = (D_L - D_T) \frac{V_1 V_2}{|V|^2} \qquad (3.23)$$

$$D_{13} = D_{31} = (D_L - D_T) \frac{V_1 V_3}{|V|^2}$$

$$D_{23} = D_{32} = (D_L - D_T) \frac{V_2 V_3}{|V|^2}$$

where $|V|$ is equal to $(V_1^2 + V_2^2 + V_3^2)$**0.5.

If x=1, y=2, and z=3, then the dispersion coefficients for isotropic porous media are:

$$D_{ij} = \begin{vmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{vmatrix} \qquad (3.24)$$

Kinetic Coefficients

The changes due to the reaction of the solute with its surroundings include adsorption, desorption, biodegradation, volatilization, precipitation, and chemical transformation. K is the rate of production of the solute in different reactions.

$$K = K_a + K_b + K_t + K_V \qquad (3.25)$$

K_a is the reaction constant for the solute's change in adsorption concentration. K_b is the biodegradation constant; organic compounds are decomposed by microorganisms that obtain carbon and hydrogen from these processes for cell synthesis. The energy necessary for this metabolism is supplied by the digestion of substances rich in energy into simpler compounds and finally into CO_2 and H_2O. Zoetman, Harman, Linders, Morra, and Sloof (1981) calculated the constant for tolune to be 0.3, ethylene 0.6, benzene 1, and dichlomethane 10. K_v is the volatilization constant. Highly volatile materials such as gasoline and chlorinated hydrocarbons may escape by diffusion from the soil into the atmosphere. Volatilization provides a measure of the tendency of a substance to vaporize. Tinsley (1979) and Khan (1980) give more details of factors that influence volatilization of organic chemicals in soil. K_t is the chemical transformation constant. Chemical reaction leads to an "elimination" or "disappearance" of a given chemical in the groundwater environment. K_p is the precipitation constant. This is another chemical interaction. Several other reactions are involved in the general K term such as desorption, etc.

$$\frac{\partial S}{\partial t} = KC \tag{3.26}$$

In this study, one species and first order kinetic linear-equilibrium adsorption isotherm is assumed. Several other adsorption isotherms are summarized by Pinder (1977).

If a radioactive material effects a change in its environment, then the adsorption term becomes

$$\frac{\partial S}{\partial t} = \lambda C \qquad (3.27)$$

where λ is the radioactive constant and

$$\lambda = \frac{\ln 2}{T^{1/2}} \qquad (3.28)$$

If the sources or sinks for the solute are different, then the reactant's concentration can be represented by Q

$$Q = Q_w \, \delta(x-x_1)\delta(y-y_1)\delta(z-z_1) \qquad (3.29)$$

where Q = fluid sources or sinks term

Q_w = strength of fluid source or sink (L^3T^{-1})

δ = Dirac Delta function on (L^{-1})

C^* = solution concentration of the fluid source or sink (ML^{-3})

The equation can now be written as:

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x_i}\left(D_{ij}\frac{\partial C}{\partial x_j}\right) - \frac{\partial}{\partial x_i}(CV_i) + QC^* - \lambda C + KC$$

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x}\left(D_{xx}\frac{\partial C}{\partial x} + D_{xy}\frac{\partial C}{\partial z} + D_{xz}\frac{\partial C}{\partial y}\right)$$

$$+ \frac{\partial}{\partial y}\left(D_{yx}\frac{\partial C}{\partial x} + D_{yy}\frac{\partial C}{\partial y} + D_{yz}\frac{\partial C}{\partial z}\right)$$

$$+ \frac{\partial}{\partial z}\left(D_{zx}\frac{\partial C}{\partial x} + D_{yz}\frac{\partial C}{\partial y} + D_{zz}\frac{\partial C}{\partial z}\right) \qquad (3.30)$$

$$- \frac{\partial V_x C}{\partial x} - \frac{\partial V_y C}{\partial y} - \frac{\partial V_z C}{\partial z} + QC^* - \lambda C + KC$$

or

$$\frac{\partial C}{\partial t} = \nabla(D\nabla C) - \nabla\cdot(\vec{V}C) - \lambda C + KC + QC^*$$

CHAPTER IV

SOLUTE TRANSPORT BY FINITE ELEMENTS

The finite element method is a powerful numerical technique for solving differential equations in different disciplines, including groundwater hydrology. The general steps for the method include:

1. The domain of interest is divided into a number of elements and described by nodal points.
2. The basic function is chosen.
3. The weighted integral of the residue is set to zero in order to obtain a set of simultaneous equations.
4. The resulting set of equations is solved to obtain the values of dependent variables at all nodes.

Galerkin's Approach

The dispersion equation is represented by

$$\begin{aligned}\frac{\partial C}{\partial t} = {} & \frac{\partial}{\partial x}\left(D_{xx}\frac{\partial C}{\partial x} + D_{xy}\frac{\partial C}{\partial y} + D_{xz}\frac{\partial C}{\partial z}\right) \\ & + \frac{\partial}{\partial y}\left(D_{yx}\frac{\partial C}{\partial x} + D_{yy}\frac{\partial C}{\partial y} + D_{yz}\frac{\partial C}{\partial z}\right) \qquad (4.1) \\ & + \frac{\partial}{\partial z}\left(D_{zx}\frac{\partial C}{\partial x} + D_{zy}\frac{\partial C}{\partial y} + D_{zz}\frac{\partial C}{\partial z}\right)\end{aligned}$$

$$-\frac{\partial(V_xC)}{\partial x} - \frac{\partial(V_yC)}{\partial y} - \frac{\partial(V_zC)}{\partial z} + QC^* - \lambda C - KC$$

This equation can be shown by $L(C)=0$. To solve the differential equation by Galerkin's technique, the equation can be written as:

$$\begin{aligned}(L(C) = {} & \frac{\partial C}{\partial t} - KC - \frac{\partial}{\partial x}\left(D_{xx}\frac{\partial C}{\partial x} + D_{xy}\frac{\partial C}{\partial z} + D_{xz}\frac{\partial C}{\partial y}\right) \\ & + \frac{\partial}{\partial y}\left(D_{yx}\frac{\partial C}{\partial x} + D_{yy}\frac{\partial C}{\partial y}\ D_{yz}\frac{\partial C}{\partial z}\right) \\ & + \frac{\partial}{\partial z}\left(D_{zx}\frac{\partial C}{\partial x} + D_{yz}\frac{\partial C}{\partial y} + D_{zz}\frac{\partial C}{\partial z}\right) \\ & - \frac{\partial V_xC}{\partial x} - \frac{\partial V_yC}{\partial y} - \frac{\partial V_zC}{\partial z} - QC^* + \lambda C\end{aligned} \tag{4.2}$$

The function C can be approximated by the piecewise linear function $\bar{C}$.

$$C(x,y,z,t) \approx \bar{C}\ (x,y,z,t) = \sum_{i=1}^{n} C_i(t)W_i\ (x,y,z) \tag{4.3}$$

where $W_i(x,y,z)$ is a basic function. It is a set of linearly independent functions and satisfies the required boundary conditions. The unknown coefficient $C_i(t)$ is the discrete nodal value of the concentration as a function of time. The summation index is 'i'. The number of nodes within the solution domain is 'n'.

In order to get an exact solution, the residual error R is minimized.

$$L(C) - L(\bar{C}) = R \tag{4.4}$$

So that L{C(x,y,z)} must be orthogonal to the shape function. According to the theory of inner product (Churchill, 1941),

$$\int_V L(\bar{C}) W_k dV = 0 \tag{4.5}$$

where W_i is the weighting function in Galerkin's method. The weighting function is equal to shape function

$$L \{ \sum_{i=1}^{n} C_i(t) W_i(x,y,z) \} W_k(x,y,z) dV = 0, \ k = 1, 2, \ldots n \tag{4.6}$$

in which there are n undetermined coefficients C_i. If the set of trial functions W_k are orthogonal in the given domain,

$L(\bar{C})$ will approach the exact solution of L(C):

$$L(C) - L(\bar{C}) = 0 \tag{4.7}$$

In the vector form:

$$\int_V L(\bar{C}) W_k(x,y,z) dV = \int_V L\{K\bar{C} + \frac{\partial \bar{C}}{\partial t} - \nabla (D \cdot \bar{C})$$

$$+ \nabla\cdot(V\bar{C}) - \lambda\bar{C} + QC\}W_k(x,y,z)dV \qquad (4.8)$$

Equation (4.8) depends on the actual case. Some solute will not react and adsorption will not occur.

If first order linear equilibrium adsorption isotherm occurs, $S = KC = K\bar{C}$, or if radioactive decay happens, $\bar{C}$ will remain in the equation, otherwise the term is "zero." For simplicity, $\bar{C} = C$, from the above derivation.

$$\int_V \frac{\partial C}{\partial t} - KC - \frac{\partial}{\partial x_i}(D_{ij}\frac{\partial C}{\partial x_j}) + \nabla\cdot(\bar{V}C) + \lambda C)W_k dV - \int_V QC^{*}W_k dV = 0 \qquad (4.9)$$

and

$$\nabla(D\cdot\nabla C) = \frac{\partial}{Mx_i}(D_{ij}\frac{\partial C}{Mx_j}) \qquad (4.10)$$

The third term in equation (4.9) can be evaluated using Green's theory as

$$\int_V \frac{\partial}{\partial x_i}(D_{ij}) - \frac{\partial C}{\partial x_j})dV = \int_A W_k D_{ij}\frac{\partial C}{\partial x_j})dV - \int_V D_{ij}\frac{\partial W_i \partial C}{\partial x_i \partial x_j}dV \qquad (4.11)$$

The last term in equation (4.11) becomes

$$\int_V \frac{\partial}{\partial x_i}(W_k D_{ij}\frac{\partial C}{\partial x_j})dV = \int_A W_k D_{ij}\frac{\partial C}{\partial x_j}\ell_i \, dA \qquad (4.12)$$

where ℓ_i are the direction cosines of A, and A is the boundary of the aquifer. Thus, equation (4.9) can be written as:

$$\int_V \{\frac{\partial C}{\partial t} - KC + \lambda C + \nabla(VC)\}W_k dV - \int_V \frac{\partial}{\partial x_i} (W_k D_{ij} \frac{\partial C}{\partial x_j})dV$$

$$+ \int_A W_k D_{ij} \frac{\partial C}{\partial x_i} l_i dA + \int_V D_{ij} \frac{\partial W_k}{\partial x_i} \frac{\partial C}{\partial x_j} dV - \int_V QC^* W_k dV = 0 \tag{4.13}$$

$$\int_V (\frac{\partial C}{\partial t} - KC + \lambda C) \cdot W_i W_k dV + \int_V W_k V_i \frac{\partial W}{\partial x_i} dV + \int_V W_k W_i \frac{\partial V_i}{\partial x_i} dV$$

$$+ \int_A W_k D_{ij} \frac{\partial C}{\partial x_j} l_i dA + \int_V D_{ij} \frac{\partial W_k}{\partial x_i} \frac{\partial W_i C}{\partial x_j} dV \tag{4.14}$$

$$- \int_A W_k D_{ij} \frac{\partial C W_i}{\partial x_j} l_i dA - \int_V QC^* W_k dV = 0$$

Equation (4.14) can be represented by the following matrix equation:

$$[GN]\{C\} + [GM] \{\frac{\partial C}{\partial t}\} + \{GF\} = 0 \tag{4.15}$$

where:

$$[GN] = \sum_e \int_V \{D_{ij} \frac{\partial W_k}{\partial x_i} \frac{\partial W_i}{\partial x_j} + V_i W_k \frac{\partial W_i}{\partial x_i} + W_i W_k \frac{\partial V_i}{\partial x_i}$$

$$+ W_i W_k \frac{\partial V_i}{\partial x_i} + (-K + \lambda) W_i W_k\} dV$$

$$[GM] = \sum_e \int_V W_i W_k dV$$

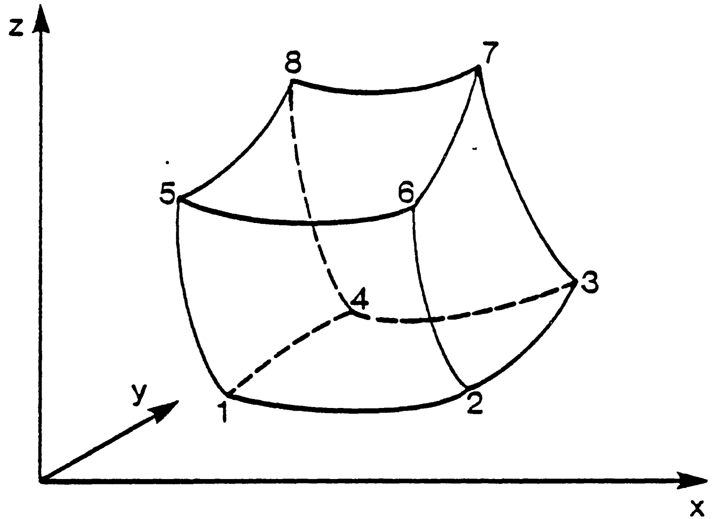
$$[GF] = \sum_{e} \int_{V} W_k Q C^{*} \, dV - \int_{A} W_k D_{ij} \frac{\partial C W_i}{\partial x_j} \ell_i dA$$

Shape Functions

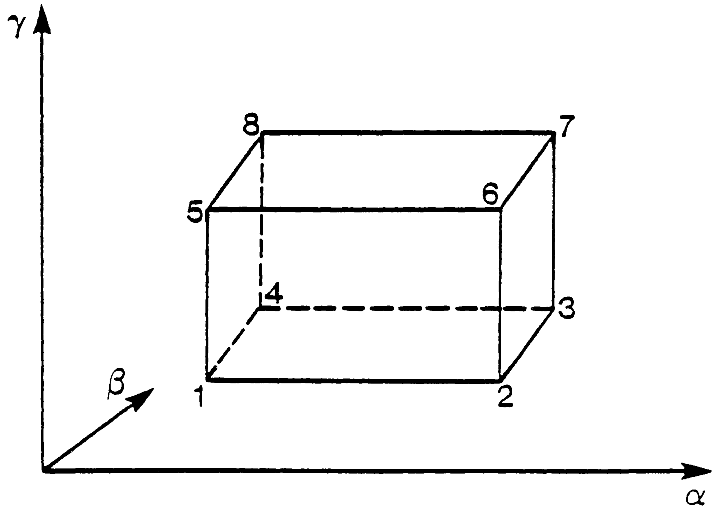
Selecting the adequate shape function usually leads to improving the accuracy and efficiency of solving the problem. Applying linear, quadratic, and cubic hexahedral elements, one can easily transform the isoparametric concept from quadrilaterals to deformed hexahedra. Isoparametric elements were first introduced by Ergatoudis et al. (1968). Since then, many papers have been published giving extensive details on how to choose the appropriate shape function for various forms of elements (Segerlind, 1976; Zienkiewicz, 1977; Rao, 1982; and Lapidus and Pinder, 1984). The major difference between the isoparametric element and nondeformed elements is in the transformation of global coordinates to local coordinates using the Jacobian matrix. Figure 3 shows an isoparametric element in local and global coordinates.

The Jacobian matrix is given as:

$$[J] = \begin{vmatrix} \frac{\partial x}{\partial \alpha} & \frac{\partial y}{\partial \alpha} & \frac{\partial z}{\partial \alpha} \\ \frac{\partial x}{\partial \beta} & \frac{\partial y}{\partial \beta} & \frac{\partial z}{\partial \beta} \\ \frac{\partial x}{\partial r} & \frac{\partial y}{\partial r} & \frac{\partial z}{\partial r} \end{vmatrix} \qquad (4.16)$$



(a) GLOBAL COORDINATE



(b) LOCAL COORDINATE

Figure 3. Isoparametric Element in Global and Local Coordinates

The relationship between global and local derivatives is given as

$$\begin{vmatrix} \frac{\partial W_i}{\partial x} \\ \frac{\partial W_i}{\partial y} \\ \frac{\partial W_i}{\partial z} \end{vmatrix} = [J]^{-1} \begin{vmatrix} \frac{\partial W_i}{\partial \alpha} \\ \frac{\partial W_i}{\partial \beta} \\ \frac{\partial W_i}{\partial r} \end{vmatrix} \qquad (4.17)$$

Shape functions are given below for linear, quadratic, cubic, and mixed elements. The node numbers correspond to the nodes shown in Figure 4.

1. Linear quadrilateral element (8 nodes):

$$W_i = (1+\alpha\alpha_i)(1+\beta\beta_i)(1+rr_i)(\alpha\alpha_i+\beta\beta_i-2)/8, \quad i = 1, 2, ...8$$

2. Quadratic quadrilateral element (20 nodes):

(i) $W_i = (1-\alpha\alpha_i)(1+\beta\beta_i)(1+rr_i)(\alpha\alpha_i+\beta\beta_i-2)/8$

where i = 1, 2, 3, 4, 5, 6, 7, 8

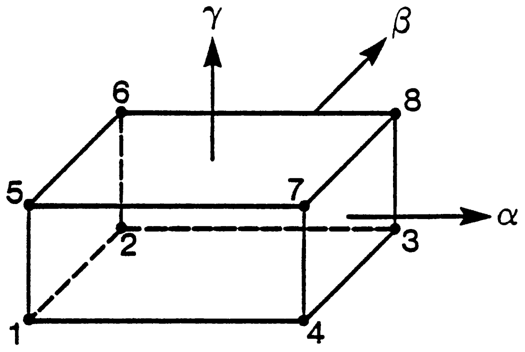
(ii) $W_i = (1-r^2)(1+\alpha\alpha_i)(1+\beta\beta_i)/4$, i = 9, 10, 11, 12

(iii) $W_i = (1-\alpha^2)(1+\beta\beta_i)*1+rr_i)/4$, i = 13, 14, 15, 16

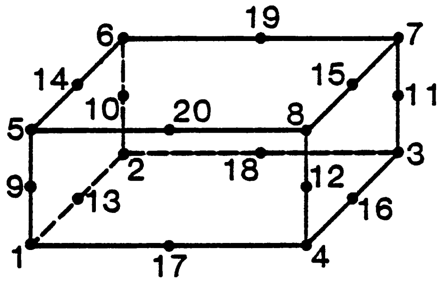
(iv) $W_i = (1-\beta^2)(1+\alpha\alpha_i)(1+rr_i)/4$, i = 17, 18, 19, 20

3. Cubic quadrilateral elements (32 nodes):

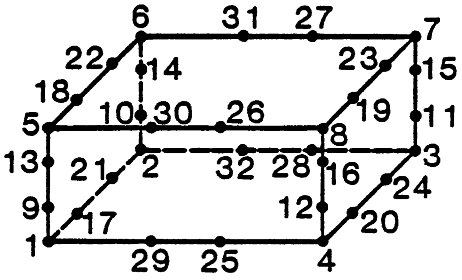
(i) $W_i = (1+\alpha\alpha_i)(1+\beta\beta_i)(1+rr_i)\{9(\alpha^2+\beta^2+r^2)-19\}/64$



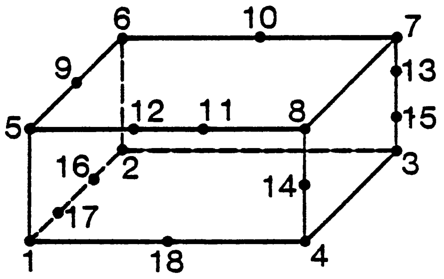
(a) LINEAR ELEMENT



(b) QUADRATIC ELEMENT



(c) CUBIC ELEMENT



(d) MIXED ELEMENT

Figure 4. Prism Elements for Three-Dimensional Model

where i = 1, 2, 3, 4, 5, 6, 7, 8

(ii) $W_i = 9(1-\alpha^2)(1+9\alpha\alpha_i)(1+\beta\beta_i)(1+rr_i)/64$

where i = 17, 18, 19, 20, 21, 22, 23, 24

(iii) $W_i = 9(1-\beta^2)(1+9\beta\beta_i)(1+\beta\beta_i)(1+\alpha\alpha_i)/64$

where i = 25, 26, 27, 28, 29, 30, 31, 32

(iv) $W_i = 9(1-r^2)(1+9rr_i)(1+\alpha\alpha_i)(1+\beta\beta_i)/64$

where i = 9, 10, 11, 12, 13, 14, 15, 16

4. Mixed quadrilateral elements (18 nodes):

(i) Linear side: W_i for i = 1 = 1, 2, 3, 4, 5, 6, 7, 8

(ii) Quadratic side: (a) W_i for i = 10, 14
(b) W_i for i = 9
(c) W_i for i = 18

(iii) Cubic side: (a) W_i for i = 16, 17

(b) Wi for i = 11, 12
(c) W_i for i = 13, 15

Segerlind (1976) defined $\alpha_o = \alpha\alpha_1$, $\beta_o = \beta\beta_i$, and $r_o = rr_i$. For the corner of the linear element:

$\alpha_o = \alpha\alpha_i = -\alpha$, since $\alpha_i = -1$ and $\beta_o = -\beta$, $r_o =- r$

Then, W_i becomes

$$W_i = \frac{1}{8}(1 - \alpha)(1 - \beta)(1 - r)$$

For the quadratic element:

1. Corner node:

$$W_i = \frac{1}{64}(1 + \alpha_o)(1 + \beta_o)(1 + r_o)\{9(\alpha^2 + \beta^2 + r^2) - 19\}$$

2. Midside node:

$$\alpha = 0; \ \beta_i = + 1; \ r = + 1$$

$$W_i = \frac{1}{64}(1 - \alpha^2)(1 + 9\alpha_o)(1 + \beta_o)(1 + r_o)$$

For the cubic element:

1. Corner node:

$$W_i = \frac{1}{64}(1 + \alpha_o)(1 + \beta_o)(1 + r_o)\{9(\alpha^2 + \beta^2 + r^2)-19\}$$

2. Midside node:

$$\alpha = + \frac{1}{3}; \quad \beta_i = + 1; \quad r = + 1$$

$$W_i = \frac{1}{64}(1 - \alpha^2)(1 + 9\alpha_o)(1 + \beta_o)(1 + r_o)$$

Numerical Integration

Gaussian quadrature integration is used in this study. The range of the integral is defined between -1 and 1. Lapidus and Pinder (1982) gave the appropriate Gaussian quadrature expression as

$$\int_{-1}^{1} f(\alpha) = \sum_{i=1}^{n} W_i f(\alpha_i) \quad + \quad R_\eta$$

where W_i = weighting factor

α_i = Coordinate of the i^{th} integration point (Gauss point)

n = total number of integration points

R_n = $2**(2n+1)(n!)**4(2n+1)**(-1)\{(2n!)\}**(-3)\left.\frac{d^{2\eta}f}{d_\alpha{}^{2\eta}}\right|_{\alpha=\Theta}$

$-1 < \Theta < 1$

A polynominal of degree (2n-1) can be integrated exactly by using n integration points. The weighting coefficients and integration points are computed using Legendre polynominals. The technique is often called the Gauss-Legendre quadrature method. Zienkiewicz (1971) tabulated the integration points and weights up to 10 points, as shown in Table I. For the three-dimensional case, the formula becomes

$$\int_{-1}^{1}\int_{-1}^{1}\int_{-1}^{1} f(\alpha,\beta,r)d\alpha d\beta dr = \sum_{k=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} W_i W_j W_k f(\alpha_i,\beta_j,r_k)$$

TABLE I

ABSCISSAE AND WEIGHT COEFFICIENTS OF THE GAUSSIAN QUADRATURE FORMULA

$$\int_{-1}^{1} f(x)dx = \sum_{i=1}^{n} W_k f(a_i)$$

n	Weighting Coefficient (W_k)	Abscissae ($+a$)
1	2.00000 00000	0.00000 00000
2	1.00000 00000	0.57735 02691
3	0.55555 55555	0.77459 66692
	0.88888 88888	0.00000 00000
4	0.34785 48451	0.86113 63115
	0.65214 51548	0.33998 10435
5	0.23692 68850	0.90617 98459
	0.47862 86704	0.53846 93101
	0.56888 88888	0.00000 00000
6	0.17132 44923	0.93246 95142
	0.36076 15730	0.66120 94864
	0.46791 39345	0.23861 91860
7	0.12948 49661	0.94910 79123
	0.27970 53914	0.74153 11855
	0.38183 00505	0.40584 51513
	0.41795 91836	0.00000 00000
8	0.10122 85362	0.96028 98564
	0.22238 10344	0.79666 64774
	0.31370 66458	0.52553 24099
	0.36268 37833	0.18343 46424
9	0.08127 43883	0.96816 02395
	0.18064 81606	0.83603 11073
	0.26061 06964	0.61337 14327
	0.31234 70770	0.32425 34234
	0.33023 93550	0.00000 00000
10	0.06667 13443	0.97390 65285
	0.14945 13491	0.86506 33666
	0.21908 63625	0.67940 95682
	0.26926 67193	0.43339 53941
	0.29552 42247	0148870 43389

Node Numbering and Assembly of Elements

Assigning a number to a node is a very important step in the finite element method. Labeling the node in a right manner saves computer storage and increases computational efficiency in obtaining a solution. Proper numbering of the nodes gives a banded matrix instead of a full matrix. A matrix is banded because zeros beyond the bandwidth need not be stored on the computer. The method of calculating the bandwidth has been defined by Segerlind (1976), Zienkiewicz (1971), and Rao (1982). They have given the equation as

$$\text{NBAND} = (D + 1) * \text{NDOF} \tag{4.18}$$

where NBAND = bandwidth

D = maximum largest difference in the node number occurring for all elements

NDOF = number of degrees of freedom at each node

The equation shows that D has to be minimized in order to minimize the bandwidth. Cook (1981) points out that a shorter bandwidth can be obtained simply by numbering the nodes across the shortest dimension of the matrix.

After the matrices have been calculated for each element, they are assembled to form a global system. Figure 5(a) shows the domain to be divided into five elements, and Figures 5(b) and 5(c) show how they are assembled together.

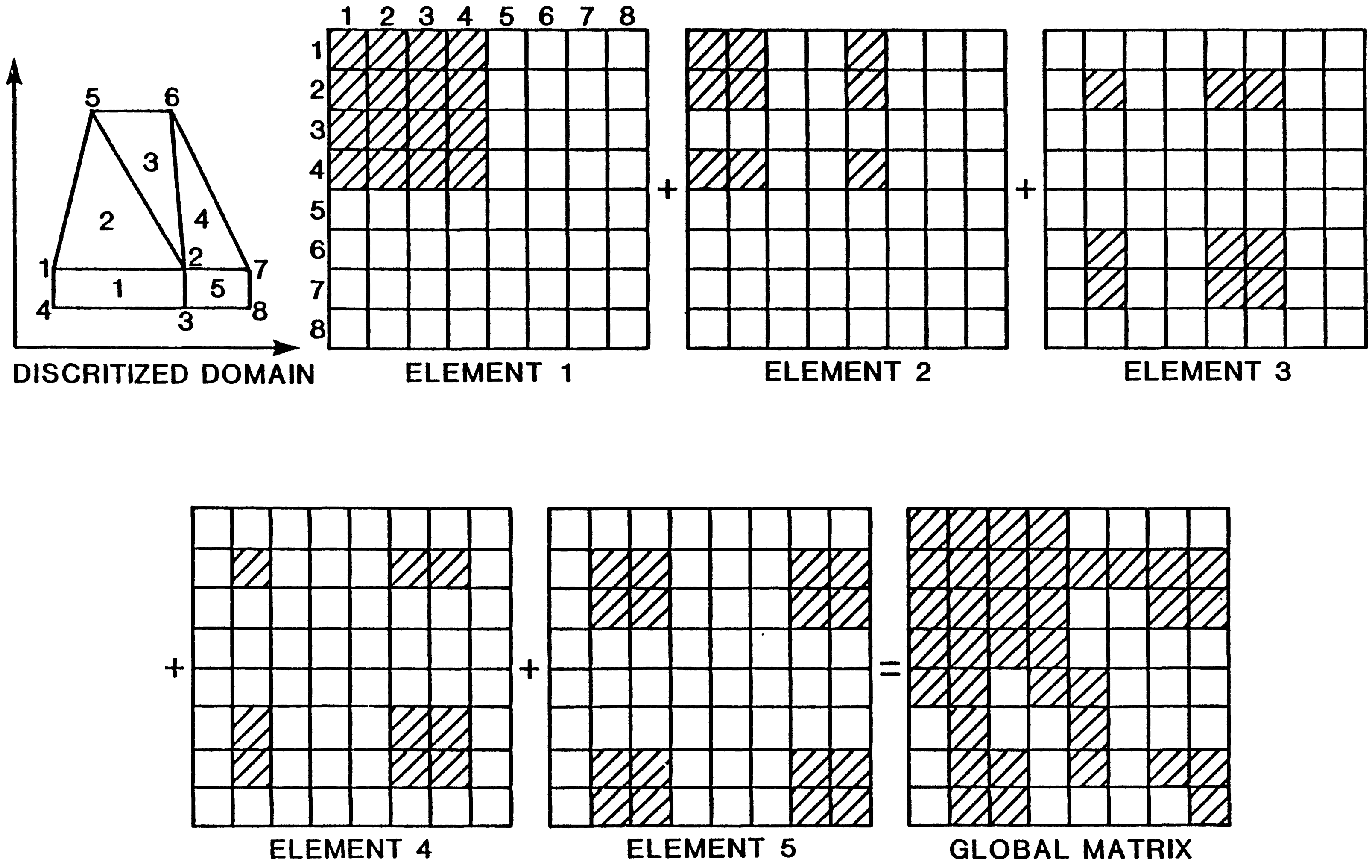


Figure 5. Illustration of Assemblage

Initial and Boundary Conditions

Before any of the partial differential equations previously derived can be solved, initial and boundary conditions must be specified. The initial condition is the value of the dependant variable at time zero over the whole domain. This could be

$$C = C_o(x,y,z,t)$$

For groundwater applications, two types of boundary are generally used: (1) specified value, and (2) specified flux. Whether the value is head, concentration, or temperature depends on the equation. The value in this study is concentration.

With the specified value type, values of concentration are specified along the boundary, which also is known as the Dirichlet Condition.

Concentration is specified along the boundary and equated to the normal derivative, also known as the Newman condition, where the flux is specified.

CHAPTER V

SOLUTION OF FINITE ELEMENT EQUATIONS

This chapter will describe how the solute transport equation developed in Chapter III can be solved.

Discretization in Time Domain

The finite element technique has been applied to the special derivative, while the time derivative has usually been approximated by using the finite difference method. The element equation developed in Chapter IV can be written as

$$[GN]\{C\} + [GM]\{\frac{\partial C}{\partial t}\} + \{GF\} = 0 \tag{5.1}$$

Remson et al. (1971), Pinder and Gray (1977), and Huykorn et al. (1983) replaced the time derivative by a weighted finite difference approximation. Therefore, the above equation becomes

$$\begin{aligned}&[GN](\Theta\{C\}_{t+\Delta t}+(1-\Theta)\{C\}_t)+ \frac{1}{\Delta t}[GM](\{C\}_{t+\Delta t}-\{C\}_t) \\ &= \Theta\{GF\}_{t+\Delta t}+(1-\Theta)\{GF\}_t \qquad (0<\Theta<1)\end{aligned} \tag{5.2}$$

where Θ dictates the reference point in the time of difference formula. For $\Theta = 0$, the scheme is known as the forward finite difference method; with $\Theta = 1$, it becomes the backward finite difference scheme and with $\Theta = 0.5$, it is called the central finite difference scheme.

In this study, the backward finite difference scheme has been chosen for discretization of the time. When $\Theta = 1$, it is substituted into equation (5.2) and gives

$$[GN]\{C\}_{t+\Delta t} + \left(\frac{1}{\Delta t}\right)\{\dot{C}\}_{t+\Delta t} - \left(\frac{1}{\Delta t}\right)[GM]\{C\}_{t} = \{GF\}_{t+\Delta t} \quad (5.3)$$

Stability and Convergence of Implicit Scheme

For any approximation method to be valid, it must present a solution that is close to the exact solution. If one considers a fixed point and inquires about the difference between two meshes that become finer and finer, the error goes to zero. We will say that a finite difference method is convergent. The second aspect is fixing Δx and Δt and then examining when $t \to \infty$. In doing so, one hopes that errors are not amplified. If the amplification of errors is restricted, the method is said to be stable.

Gray and Pinder (1977), Chung (1978), and Huyakorn and Pinder (1983) described the stability and convergence requirement and found that the solution to the approximating finite difference equation can be written as $C_{i,k}$. where its the pivotal node and k is the time interval. Due to the round-off errors during algebraic manipulations, a solution

$C_{i,k}$ is obtained which will differ from the time solution by a numerical error $E_{i,k}$ such that

$$E_{i,k} = C_{i,k} - \bar{C}_{i,k} \tag{5.4}$$

A numerical scheme will be considered stable if, with increased time, $E_{i,k}$ tends to zero for all the values of i. Substitution of a finite difference approximation into the homogeneous set of equations, obtained from equation (5.1), by getting {GF} equal to zero, gives an expression

$$\{C\}_{k+1} = [GN^*]\{C\}_k \tag{5.5}$$

and

$$\{C\}_o = \{W\} \tag{5.6}$$

where $\{C\}_o$ is the matrix of initial conditions and $[GN^*]$, a matrix called the amplification matrix. Two stability criteria are considered. The first criterion, defined by Saulyev (1964), defines the following norms, which are consistent inasmuch as they satisfy the Schwarz inequality (Westlake, 1968).

$$||\{C\}_k|| = \underset{1 \le i \le n}{\text{MAX}} |C_{i,k}| \tag{5.7}$$

and

$$||[GN^*]|| = \underset{1 \le i \le n}{\text{MAX}} \sum_{j=1}^{n} |GN_{i,j}| \tag{5.8}$$

Let us consider a matrix $\{\overline{W}\}$ composed of the initial conditions and slightly modified, due to rounding off of its components using the overbar notation. The equation (5.5) becomes

$$\{\overline{C}\}_{k+1} = [GN^*]\{\overline{C}\}_k \quad (k = 1, 2, \ldots k) \tag{5.9}$$

and

$$\{\overline{C}\}_o = \{\overline{W}\} \tag{5.10}$$

in which p is the total number of time steps considered. If the error vector is defined by

$$\{\overline{E}\}_k = \{C\}_k - \{\overline{C}\}_k \tag{5.11}$$

then

$$\{\overline{E}\}_{k+1} = [GN^*]\{\overline{E}\}_k \tag{5.12}$$

where $\{\overline{E}\}_o = \{W\} - \{\overline{W}\}$ (5.13)

or $\{\overline{E}\}_k = [GN^*]_k\{\overline{E}\}_o = [GN^*]_k(\{W\} - \{\overline{W}\})$ (5.14)

for the Schwarz inequality and above equation becomes

$$||\{\overline{E}\}_k|| \leq ||[GN^*]||_k||\{\overline{E}\}_o|| \tag{5.15}$$

It is apparent from equation (5.15) that the error {E} in the initial data will not grow with an increase in k, and that the solution will remain stable only if

$$||[GN^*]|| \leq 1 \tag{5.16}$$

This same relationship holds true when the error is assumed at any arbitrary time level, because this level can always be considered as a new set of initial conditions.

The second criterion is the Neumann necessary condition for stability. Chung (1978) and Huyakorn and Pinder (1983) developed the same equation as (5.1), and stated that the stability of the numerical solution can be assumed if the norm of the amplification is made smaller than unity. For a symmetric [GN*], the appropriate norm to use is the special norm $||[GN^*]||_2$. Thus, the inequality becomes

$$||[GN^*]||_2 \leq 1 \tag{5.17}$$

since $||[GN^*]||_2$ is defined as

$$||[GN^*]||_2 = \underset{I}{MAX} \, |\lambda_I| \tag{5.18}$$

where λ_I denotes the eigenvalue of [GN], the stability criterion becomes

$$M_{i}AX \, |\lambda_I| \leq 1 \tag{5.19}$$

For the explicit scheme $\Theta = 0$, substitute to equation (5.3) using k+1 step instead of t+Δt time step. As the [GF} is set equal to zero, the equation becomes

$$([GM]/\Delta t)\{C\}_{k+1} = ([GM]/\Delta t - [GN])\{C\}_k \tag{5.20}$$

and from equation (5.5)

$$[GN^*] = [GM]^{-1} \ ([GM] - \Delta t[GN] = [I] - \Delta t[GM]^{-1}[GN] \tag{5.21}$$

where [I] is a unit matrix and

$$[I] = [GN*] + \Delta t[GM]^{-1}[GN] \tag{5.22}$$

Taking matrix norm on both sides

$$1 \leq ||[GN^*]||_2 + \Delta t|| \ [GM]^{-1}||_2 \ ||[GN]||_2 \tag{5.23}$$

or

$$||[GN^*]||_2 \geq ||[I]||_2 - \Delta t||[GM]^{-1}|| \ ||[GN]||_2 \tag{5.24}$$

For stability $||[GN^*]|| \leq 1$ but

$$1 - \ \Delta t||[GM]^{-1}|| \ ||[GN]||_2 \leq 1 \tag{5.25}$$

It can be seen that a bound for Δt outside of the inequality is not valid, so the explicit scheme is conditionally stable. For implicit scheme, $\Theta = 1$

$$[GN^*] = ([GN]_2 + [GM]/\Delta t)^{-1} \ ([GM]/\Delta t) \tag{5.26}$$

It can be shown that for all values of Δt we have

$$||[GN^*]||_2 \leq ||I||_2 = 1 \tag{5.27}$$

Thus, we say the implicit is unconditionally stable. The main point of this section is to prove that the implicit scheme is stable and convergent.

Initial and Boundary Conditions

The specification of initial and boundary conditions is necessary in order to obtain a solution of the solute transport equation. The initial concentration can be calculated from field data or from previous simulation. From the Dirichlet condition, the concentration at certain nodes is specified, the Neumann Condition, the solute flux entering or leaving the aquifer is specified.

The Neumann condition can be used to represent an aquifer with well withdrawal or injection, and a constant concentration boundary in the model can represent parts of the aquifer where the concentration will not change with time. If the constant concentration represents a fluid source, the solute concentration in the source fluid must also be specified. If the boundary represents a fluid sink, then the concentration of the product will be the same as the concentration in the aquifer at the location of the sink.

The boundary condition is put into the program before the formation of the global equation, enabling one to solve the matrix in the model. The subprogram BOUND will handle this portion.

Segerlind (1976) described two methods for specifying the boundary condition: one is the deletion row and column, and the other is the multiplication of the diagonal terms by a very large number. The first method was chosen for this study. The equation for backward expression also can take the following form:

$$[GN]\{C\}_t + \frac{1}{\Delta t}[GM]([C]_t - \{C\}_{t-\Delta t}) + \{GF\}_t = 0 \quad (5.28)$$

Rearranging equation (5.28).

$$([GN] + \frac{1}{\Delta t}[GM])\{C\}_t = \frac{1}{\Delta t}[GM]\{C\}_{t-\Delta t} - \{GF\} \qquad (5.29)$$

The equation shows the value of concentration. On the right hand side are the knowns and on the other side are the unknowns. The first value of C(t) is the known value from the equation and it becomes

$$[GL]\{C\}_t = \{GF\} \qquad (5.30)$$

where $[GL] = ([GN] + [GM]/\Delta t)$, and

$GF = ([GM]/\Delta t)\{C\} - \{GF\}$

Equation (5.30) can be expressed as

$$\left|\begin{matrix} GL_{i,j} & \cdots & GL_{i,L} & \cdots & GL_{i,n} \\ \vdots & & \vdots & & \vdots \\ GL_{L,j} & \cdots & GL_{1,L} & \cdots & GL_{L,n} \\ \vdots & & \vdots & & \vdots \\ GL_{n,j} & \cdots & GL_{r,L} & \cdots & GL_{n,n} \end{matrix}\right| \left|\begin{matrix} C_i \\ \vdots \\ C_L \\ \vdots \\ C_n \end{matrix}\right| = \left\{\begin{matrix} GF_i \\ \vdots \\ GF_L \\ \vdots \\ GF_n \end{matrix}\right\} \qquad (5.31)$$

where i, j = 1, 2,...n

The value of C_L is specified according to the deletion row and column method. All the coefficients in the row 1 are set to zero except the diagonal term, which is left unchanged $GL_{L,j} = 0$, but $L \neq j$ and the L^{th} term of GF_L will be replaced by $G_{LL}C_L$.

$$\begin{vmatrix} GL_{i,j} & \cdots & GL_{i,L} & \cdots & GL_{i,n} \\ \vdots & & \vdots & & \vdots \\ GL_{L,j} & \cdots & GL_{L,L} & \cdots & GL_{L,n} \\ \vdots & & \vdots & & \vdots \\ GL_{n,j} & \cdots & GL_{n,L} & \cdots & GL_{n,n} \end{vmatrix} \begin{vmatrix} C_i \\ \vdots \\ C_L \\ \vdots \\ C_n . \end{vmatrix} = \left\{ \begin{matrix} GF_i \\ \vdots \\ GF_L \\ \vdots \\ GF_n \end{matrix} \right\} \qquad (5.32)$$

where i, j = 1,2,...n

All of the remaining equations are modified by subtracting the product $GL_{i,L}C_L$ from GF_i and then setting $GL_{L,L} = 0$, $i = 1, n$ and $i \neq L$.

$$\begin{vmatrix} GL_{i,j} & \cdots & GL_{i,L} & \cdots & GL_{i,n} \\ \vdots & & \vdots & & \vdots \\ 0 & \cdots & GL_{L,L} & \cdots & 0 \\ \vdots & & \vdots & & \vdots \\ GL_{n,j} & \cdots & GL_{n,L} & \cdots & GL_{n,n} \end{vmatrix} \begin{vmatrix} C_i \\ \vdots \\ C_L \\ \vdots \\ C_n \end{vmatrix} = \left\{ \begin{matrix} GF_i - GL_{i,L}\, C_L \\ \vdots \\ GF_L - C_L \\ \vdots \\ GF_n - GL_{n,L}\, C_L \end{matrix} \right\} \qquad (5.33)$$

The above process continues the completion, and is applied to the solution of the matrix equation.

Matrix Solution

Each numerical approximation tends to an algebraic equation for each node point. These are combined to form a matrix equation; that is, a set of N equations with N unknowns, where N is the number of nodes. The general form of equations, written in matrix form, is as equation (5.30)

$$[GL]\{C\}_t = \{GF\} \qquad (5.34)$$

Where GL is a matrix containing coefficients related to grids spacing and to aquifer properties such as dispersion coefficient. C is a vector containing the dependent variable to be determined in our case, is concentration and GF is a vector containing all known information, such as boundary condition information.

In general, a matrix equation may be solved numerically by the direct or iterative method. In the direct method, a sequence of operations is performed once, providing a solution that is exact except for machine round-off error. The iterative method is a process of successive approximations. An initial guess at the matrix solution is made, then this guess is imposed by some iterative process until an error criterion is attained.

In this study, the direct method has been used for solving the matrix, and the Gauss elimination and back substitution has been adapted to solve the matrix. The basic objective of this method is to transform the given system into an equivalent triangular system, then the triangular system can be solved by back substitution. The method is shown below.

$$\begin{array}{l}
GL^{0}_{11}\ C_1 + GL^{0}_{12}\ C_2 + \ .\ .\ .\ + GL^{0}_{1n}\ C_n = GF^{0}_{1} \\
GL^{0}_{21}\ C_1 + GL^{0}_{22}\ C_2 + \ .\ .\ .\ + GL^{0}_{2n}\ C_n = GF^{0}_{2} \\
.\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ . = \ . \\
.\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ .\ . = \ . \\
GL^{0}_{n1}\ C_1 + GL^{0}_{n2}\ C_2 + \ .\ .\ .\ + GL^{0}_{nn}\ C_n = GF^{0}_{n}
\end{array} \qquad (5.35)$$

where the superscript 0 means the original values. By solving the first equation for C_1, we obtain

$$C_1 = \frac{GF^0_1}{GF^0_{11}} - \frac{GL^0_{12}}{GL^0_{11}}C_2 - \frac{GL^0_{13}}{GL^0_{11}}C_3 - \ . \ . \ . \ . - \frac{GL^0_{1n}}{GL^0_{11}}C_n$$

Substitution of this C into the remaining equation (5.35) leads to

$$\begin{aligned}
GL^1_{22}C_2 + GL^1_{23}C_3 + \ . \ . \ . + GL^1_{2n}C_n &= GF^1_2 \\
GL^1_{32}C_2 + GL^1_{33}C_3 + \ . \ . \ . + GL^1_{3n}C_n &= GF^1_3 \\
. \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . &= \ . \\
. \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . &= \ . \\
GL^1_{n2}C_2 + GL^1_{n3}C_3 + \ . \ . \ . + GL^1_{nn}C_n &= GF^1_n
\end{aligned} \qquad (5.36)$$

In general

$$C_k = \frac{GF^{k-1}_k}{GF^{k-1}_{kk}} - \sum_{j=k+1}^{n} \frac{GL^{k-1}_{kj}}{GL^{k-1}_{kk}}C \qquad (5.37)$$

where

$$GL^k_{ij} = GL^{k-1}_{ij} - \{(GL^{k-1}_{ik}GL^{k-1}_{kj})/GL^{k-1}_{kk}\}$$

$$GF^k_i = GF^{k-1}_i - \{(GL^{k-1}_{ik}GF^{k-1})/GL^{k-1}_{kk}\}$$

$i, j = k+1,...n$

After applying the same procedure n-1 times, the original system of equations reduces to the following single equation:

$$GL^{n-1}_{nn}C_n = GF^{n-1}_n$$

then

$$C_n = \frac{GF_n^{n-1}}{GL_{nn}^{k-1}}$$

The C_{n-1}, C_{n-2},... C_{n-} value can be found in reverse order. If at any stage in the elimination process one of the pivot elements vanishes, we attempt to rearrange the remaining rows so as to obtain a nonvanishing pivot. Otherwise, the matrix GL is singular and the system has no solution. This is done in subprogram SOLVER.

CHAPTER VI

COMPUTER PROGRAM

The computer program has been written for the three-dimensional pollutant in a groundwater system. This program was written in standard FORTRAN language and run on the Oklahoma State University IBM/3081K - WATFIV system.

Main Program

The main program coordinates other subroutines; it controls input and prints output of data, dimensions the program at prescribed time increments, calls for shape function, assembles the element matrices into the global matrix, calculates the bandwidth, and solves the matrix. When maximum time has been reached, computations are determined. A flow chart for the main program and general type of finite element analysis are shown in Figures 6 and 7.

Subroutine INPUT

The subprogram reads and prints all the input data, including the specified nodes of boundary condition.

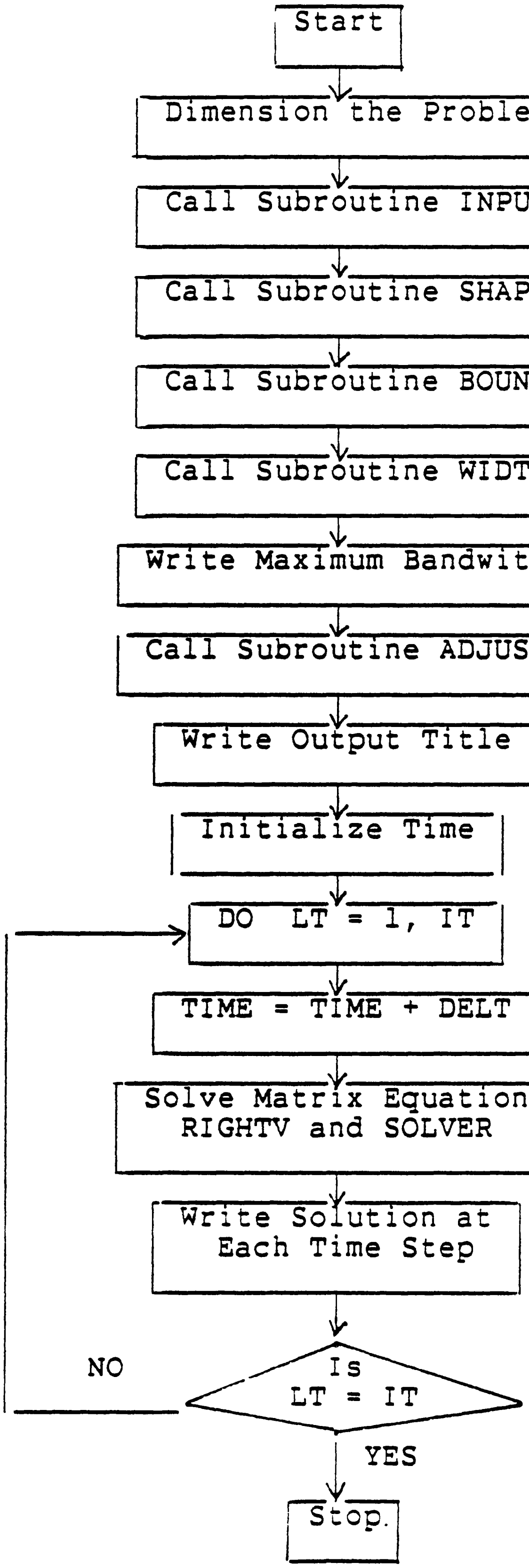


Figure 6. Flow Chart for Main Program

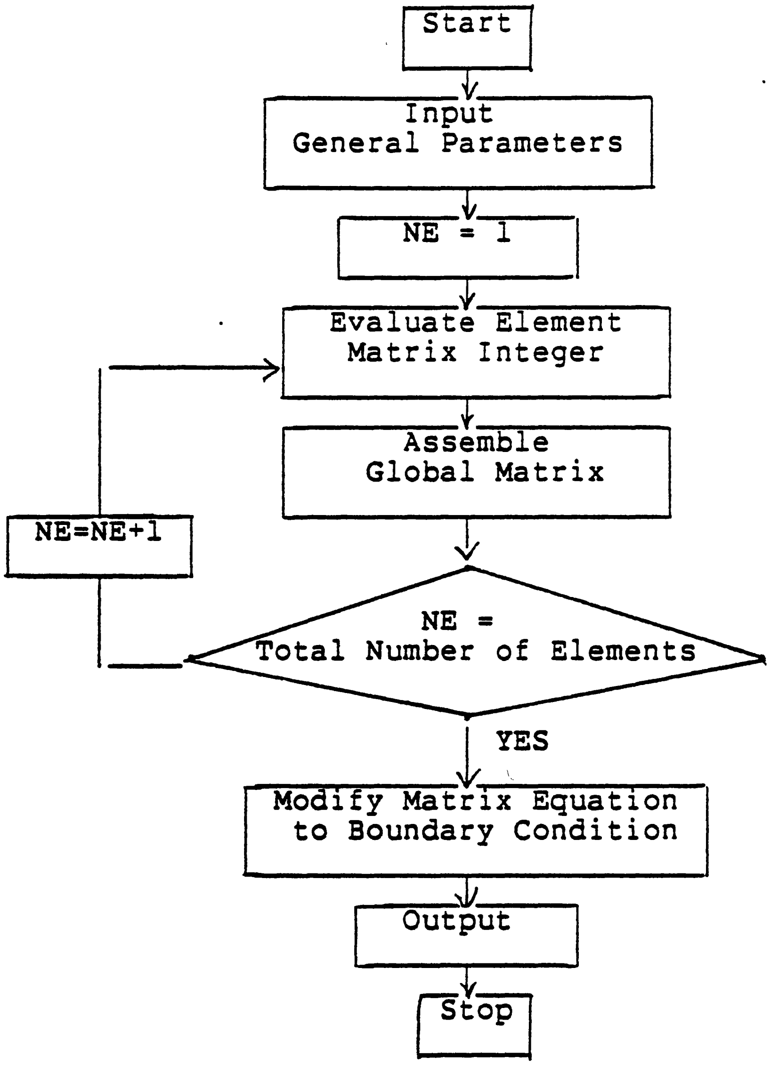


Figure 7. General Type Flow Chart for Finite Element Analysis

Subroutine SHAPE

This subprogram provides the local coordinates for each element and Gaussian Quadrature information. It does the numerical integration of the shape function for all elements. From the SHAPE subprogram, the Jacobian matrix and its determinant are obtained. Then the program calls the subprogram GLOBAL.

Subroutine GLOBAL

This subprogram assembles the element matrices into global matrix. The global matrices represent RMX (right hand side vector), STOMX, and GLOBMX.

Subroutine BOUND

This subprogram modifies the global matrix with given boundary conditions. The given known boundary conditions are ND(I). The method of deletion of rows and columns is used. The flow chart for subroutine bound is shown in Figure 8.

Subroutine WIDTH

This subprogram calculates the bandwidth. In order to minimize computer storage requirements, it is important to keep the maximum difference between any two numbers of any given element as small as possible.

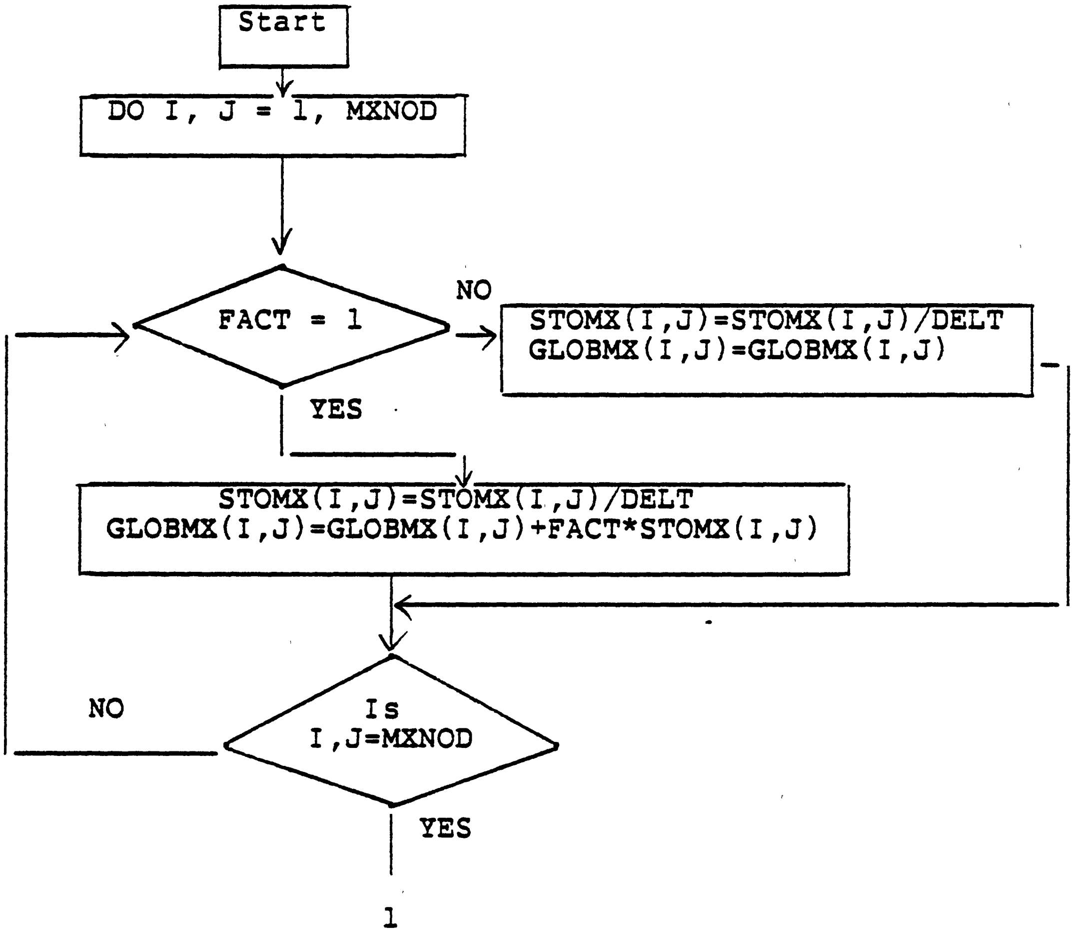


Figure 8. Flow Chart of Subroutine BOUND

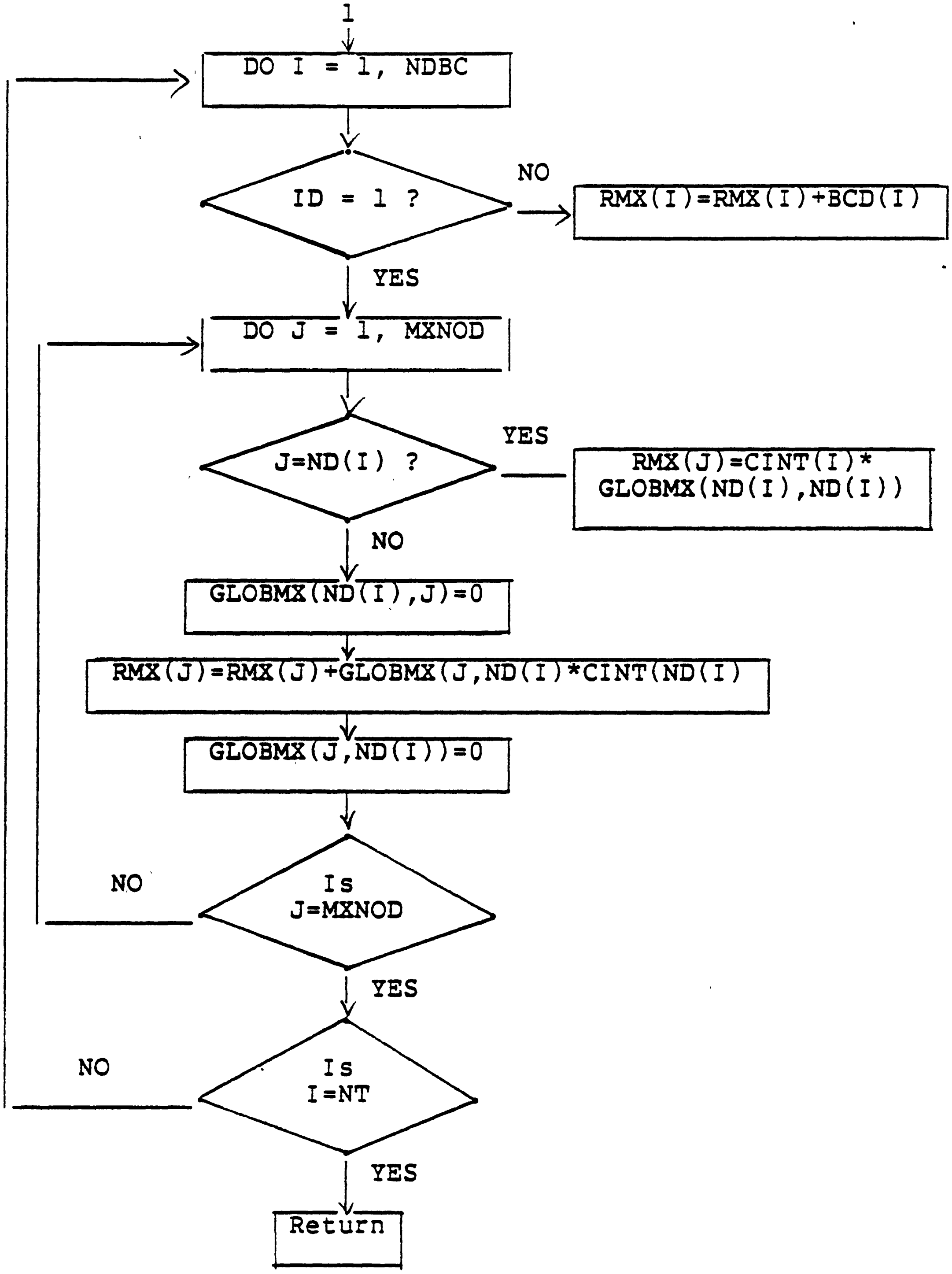


Figure 8. (Continued)

Subroutine ADJUST

This subprogram decomposes the matrix into an upper triangular matrix using the Gaussian elimination procedure.

Subroutine RIGHTV

This subprogram updates the righthand side vector, and will be called after each time step.

Subroutine SOLVER

This subprogram accepts the upper band of the matrix from subroutine ADJUST and solves the unknown in the system of equations. Using backward substitution, vector C is solved.

CHAPTER VII

ONE-DIMENSIONAL VALIDATION

Example Problem

A two-dimensional analytical solution developed by Cleary, Miller, and Pinder (1978) was used to validate the three-dimensional model. In the testing problem, the dimensions of the model are 70 by 100 feet and the thickness of the aquifer is 100 feet. Figure 9 shows the strip source with a finite width aquifer.

$$\frac{\partial C}{\partial t} + V\frac{\partial C}{\partial x} = D_x\frac{\partial^2 C}{\partial x^2} + D_y\frac{\partial^2 C}{\partial y^2} - KC \qquad (7.1)$$

subject to

$C = C_o e^{-rt}$ $x = 0;\ y_1 \geq y \geq y_2$

$C = 0$ $x = 0;$ all other y

$\frac{\partial C}{\partial y} = 0$ $y = 0$

$\frac{\partial C}{\partial y} = 0$ $y = w$

$\frac{\partial C}{\partial x} = 0$ $x \longrightarrow \infty$

$C = 0$ $t = 0$

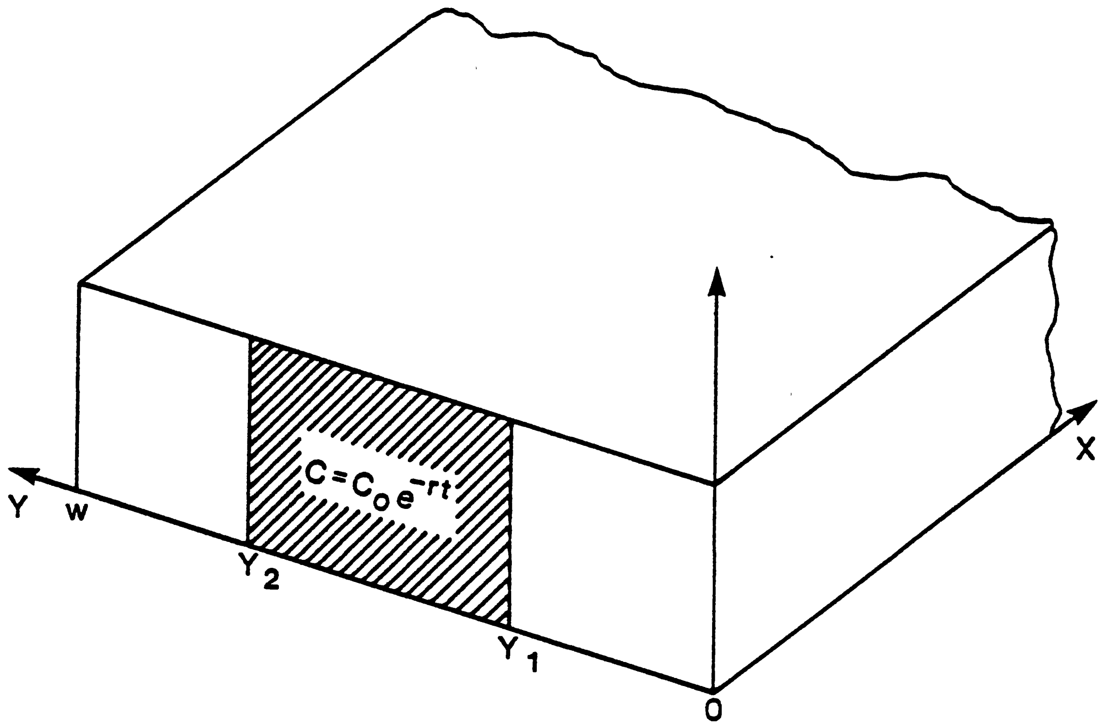


Figure 9. Strip Source with Finite Width Aquifer

In the test, the 'r' and 'K' values are set to zero. r is the first-order rate on the boundary condition and K is the first order decay constant in the system. In the y direction, velocity is 2ft/day, limits of the strip source is located between 20 to 50 feet.

Analytical Solution

The analytical solution provided by Cleary et al. (1978) is as follows:

$$\frac{C(x,y,t)}{C_o} = e^{-rt} \{u(Y-Y_1) - u(Y-Y_2)\}$$

$$- \sum_{n=0}^{\propto} L_n \cos(r_n Y)[[P_n e^{-(r_n^2 D_y tk)t} \{\mathrm{Erfc}(\frac{V_x\sqrt{t}}{2\sqrt{D_x}} - \frac{x}{2\sqrt{D_x t}})$$

$$- \exp(\frac{xV_x}{D_x}) \mathrm{Erfc}(\frac{r_x\sqrt{t}}{2\sqrt{D_x}} + \frac{x}{2\sqrt{D_x t}})\}$$

$$+ \{(k-r)P_n + D_y\frac{r_n}{W}[\sin(r_n Y_2)-\sin(r_n Y)]\} \frac{\exp(\frac{V_x x}{2D_x} - rt)}{(r_n^2 D_y+k-r)}$$

$$\{\exp(\frac{-xv_x}{2D_x} + \exp[\frac{xV_x}{2D_x} - (r_n^2 D_y+k-r)t]\mathrm{Erfc}(\frac{V_x}{2}\sqrt{\frac{t}{D_x}} + \frac{x}{2\sqrt{tD_x}})$$

$$- \exp(\frac{x}{\sqrt{D_x}}\sqrt{(\frac{V_x^2}{4D_x}+r_n^2 D_y+k-r})\mathrm{Erfc}\{\frac{x}{2\sqrt{D_x t}}\sqrt{(\frac{V_x^2}{4D_x}+r_n^2 D_y+k-r)t}\ \}\}$$

$$- \exp\left(\frac{-x}{\sqrt{D_x}}\sqrt{\left(\frac{V_n^{2}}{4D_x}+r_n^{2}D_y+k-r\right)}\right)\mathrm{Erfc}\left\{\frac{x}{2\sqrt{D_x t}}\sqrt{\left(\frac{V_x^{2}}{4D_x}+r_n^{2}D_y+k-r\right)t}\;\right\}\Big]\Big]$$

where

$$L = \begin{cases} 1/2 & \text{if } n=0 \\ 1 & \text{if } n>0 \end{cases} \quad ; \; P_n = \begin{cases} (y_2-y_1)/w & \text{if } n=0 \\ [\sin(r_n y_2)-\sin(r_n y_1)/r_n w] & \text{if } n>0 \end{cases}$$

$$r_n = n\pi/w;\; n = 0, 1, 2, 3, \ldots$$

Numerical Model

The developed model can be modified to a two-dimensional problem by making the top and bottom nodes equal. The aquifer had been discretized into 20, 50, 70, and 100 elements. The total nodes are 60, 132, 176, and 242 for different discretizations. The same input data are necessary in the numerical model. Figure 10 shows the model discretized into 70 elements.

Validation

The testing result will be compared to the center of the x direction and also compared at 20 and 50 day time periods. Figures 11 and 12 show the dimensionless result at different times. We can see that the result of 100 elements will move closer to the analytical solution. Figures 13 and 14 and Tables II and III show the error percentage between the analytical solution and model solution. The error

LENGTH OF AQUIFER	$L = 100$ FT.
THICKNESS OF AQUIFER	$H = 100$ FT.
WIDTH OF AQUIFER	$w = 70$ FT.
STRIP SOURCE	$Y_1 = 20$ FT.
	$Y_2 = 50$ FT.
NUMBER OF NODES	$N = 176$
NUMBER OF ELEMENT	$E = 70$

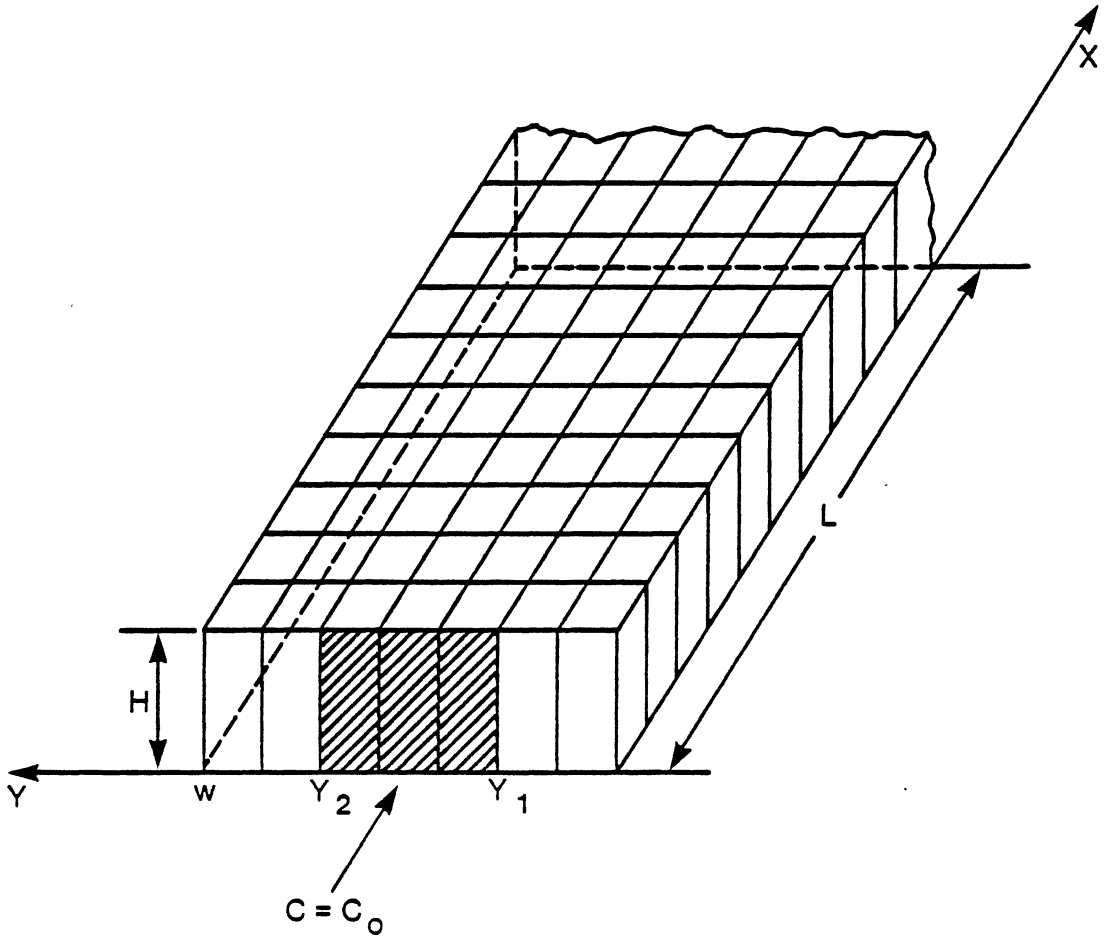


Figure 10. Model for One-Dimensional Testing

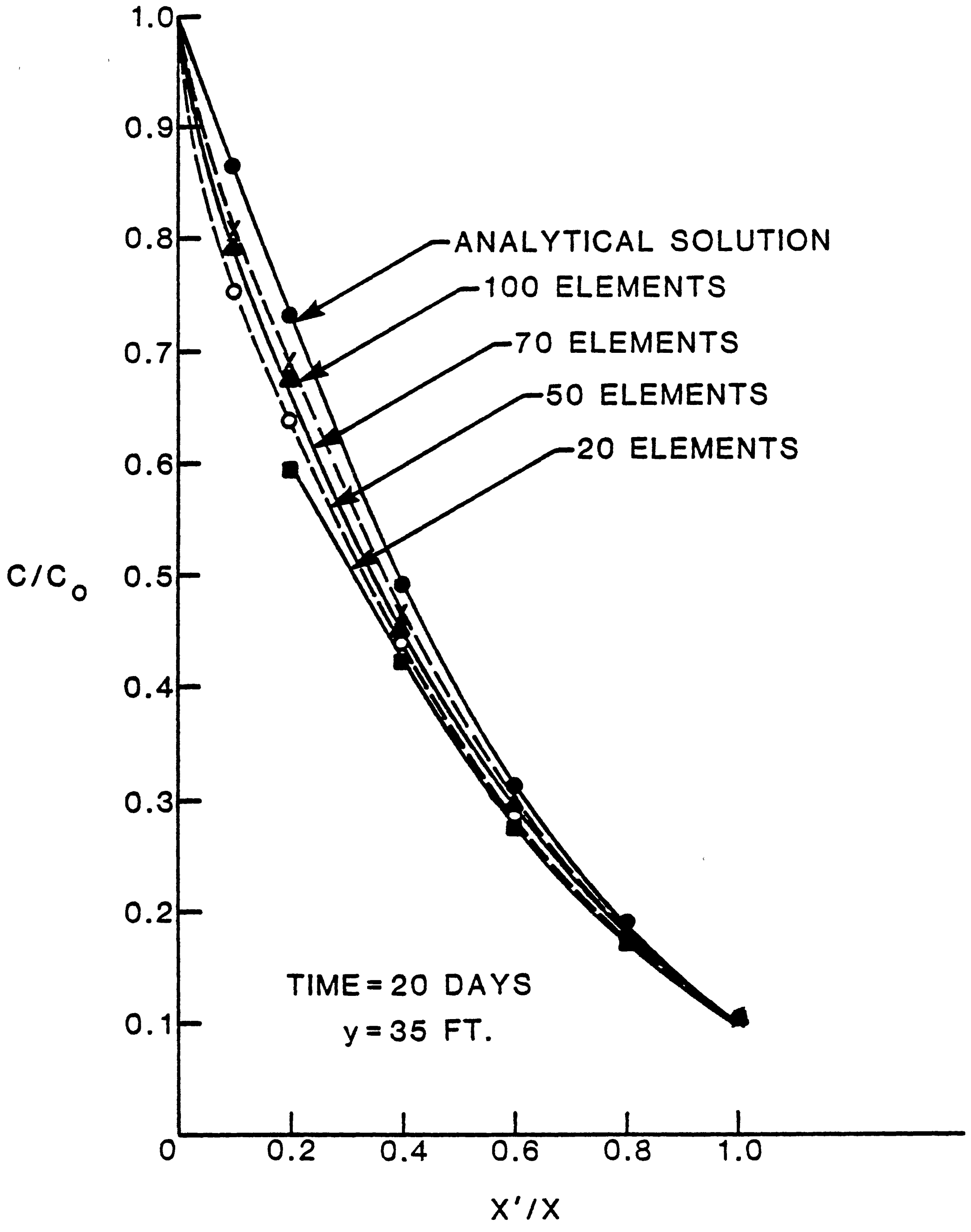


Figure 11. Comparison with Analytical Solution at Time = 20 Days

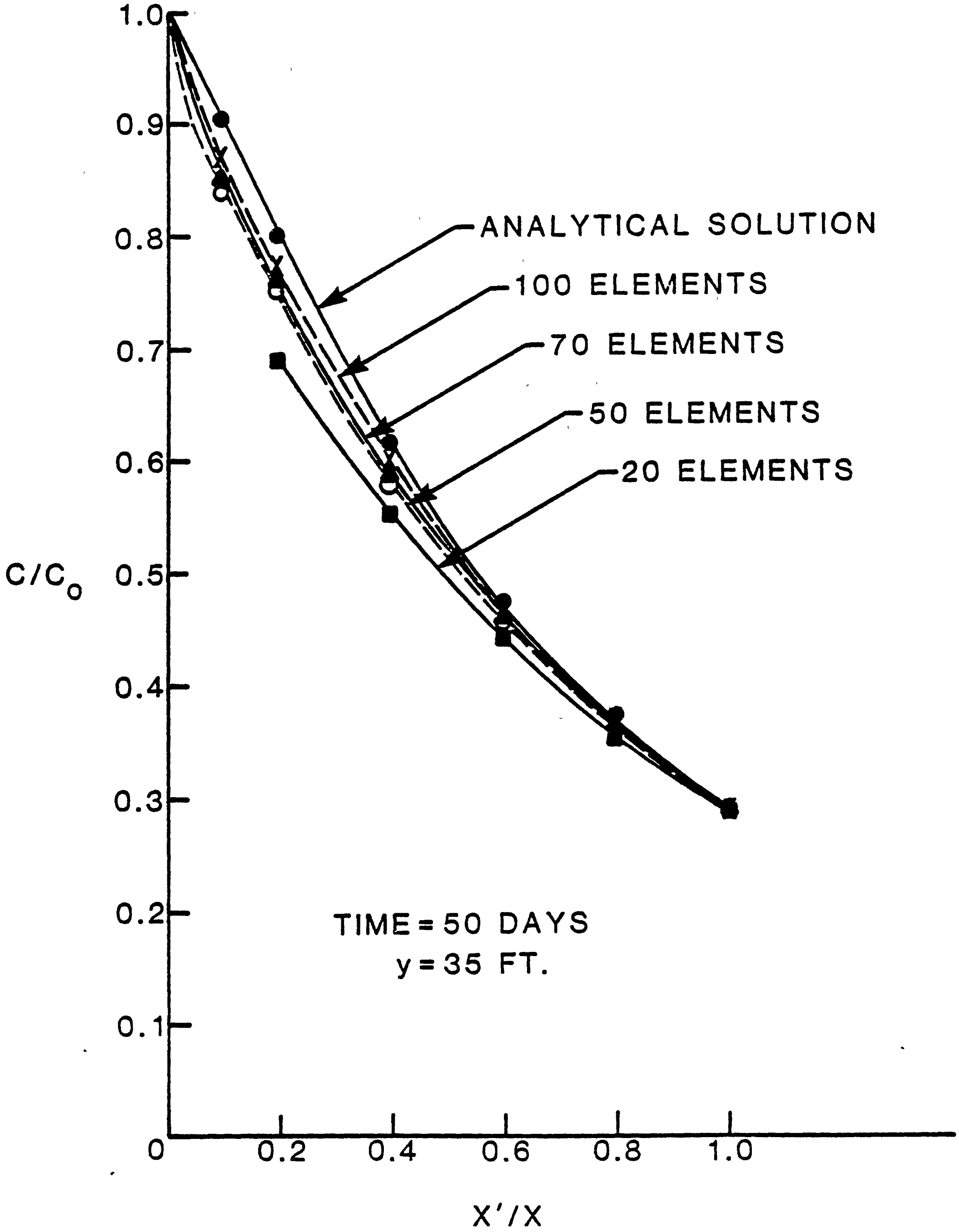


Figure 12. Comparison with Analytical Solution at Time = 50 Days

TABLE II

COMPARISON OF ANALYTICAL SOLUTION WITH THE MODEL IN 20 DAYS
Y = 35 FEET

Location From X Coordinate (Feet)	Analytical Solution Rel. Conc.[1]	100 Elements FEM [2]	Percent Error	70 Elements FEM[2]	Percent Error	50 Elements FEM [2]	Percent Error	20 Elements FEM[2]	Percent Error
10	0.867	0.805	7.2	0.796	8.2	0.754	13.0	NA [3]	NA [3]
20	0.731	0.690	5.6	0.679	7.1	0.643	12.1	0.595	18.6
40	0.491	0.450	3.3	0.465	5.3	0.446	9.2	0.421	14.3
60	0.311	0.305	1.9	0.300	3.5	0.284	8.7	0.276	11.2
80	0.186	0.187	0.0	0.183	1.7	0.173	7.5	0.171	8.5
100	0.104	0.105	0.0	0.103	0.9	0.102	1.9	0.101	2.8

[1] Relative Concentration
[2] Finite Element Method
[3] Not Applicable

TABLE III

COMPARISON OF ANALYTICAL SOLUTION WITH THE MODEL IN 50 DAYS
Y = 35 FEET

Location From X Coordinate (Feet)	Analytical Solution Rel. Conc.[1]	100 Elements FEM [2]	Percent Error	70 Elements FEM[2]	Percent Error	50 Elements FEM [2]	Percent Error	20 Elements FEM[2]	Percent Error
10	0.902	0.873	3.2	0.856	5.0	0.845	6.3	NA	NA
20	0.800	0.776	3.0	0.763	4.6	0.758	5.2	0.693	12.4
40	0.616	0.602	2.3	0.590	3.5	0.581	4.0	0.554	10.0
60	0.477	0.468	1.9	0.465	2.5	0.462	3.2	0.446	6.5
80	0.372	0.373	0.0	0.364	2.1	0.362	2.6	0.359	3.4
100	0.289	0.294	0.0	0.292	0.0	0.290	0.0	0.290	0.0

[1] Relative Concentration

[2] Finite Element Method

[3] Not Applicable

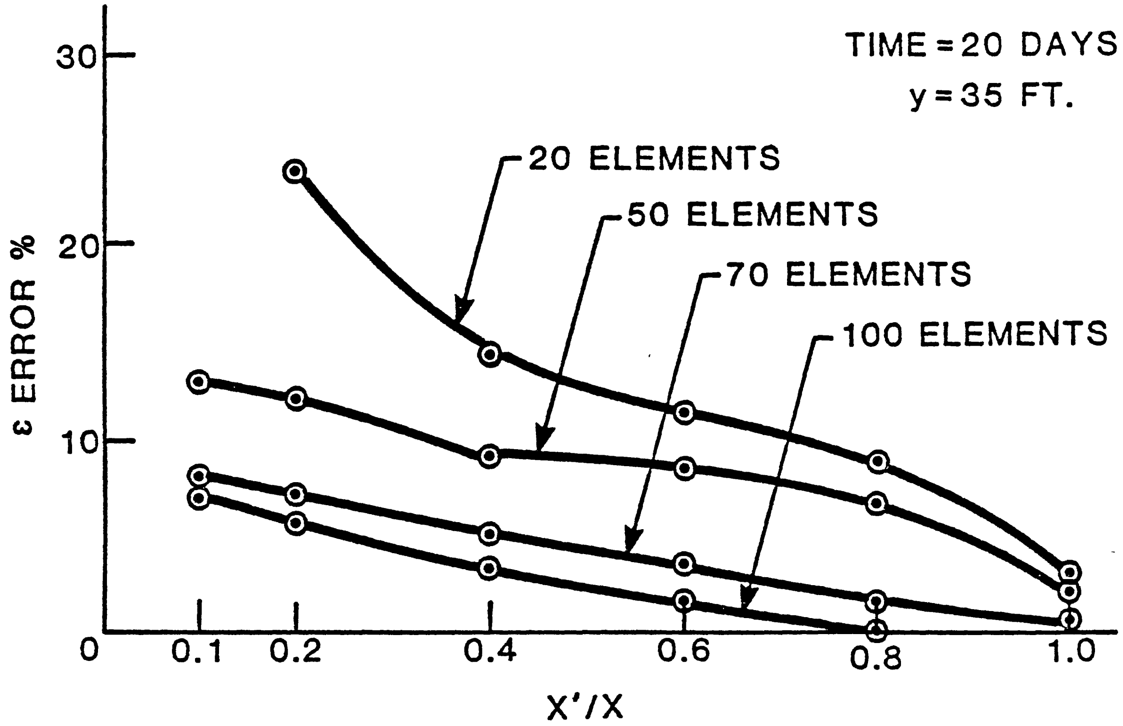


Figure 13. Error Percentage Versus x Distance at Time = 20 days

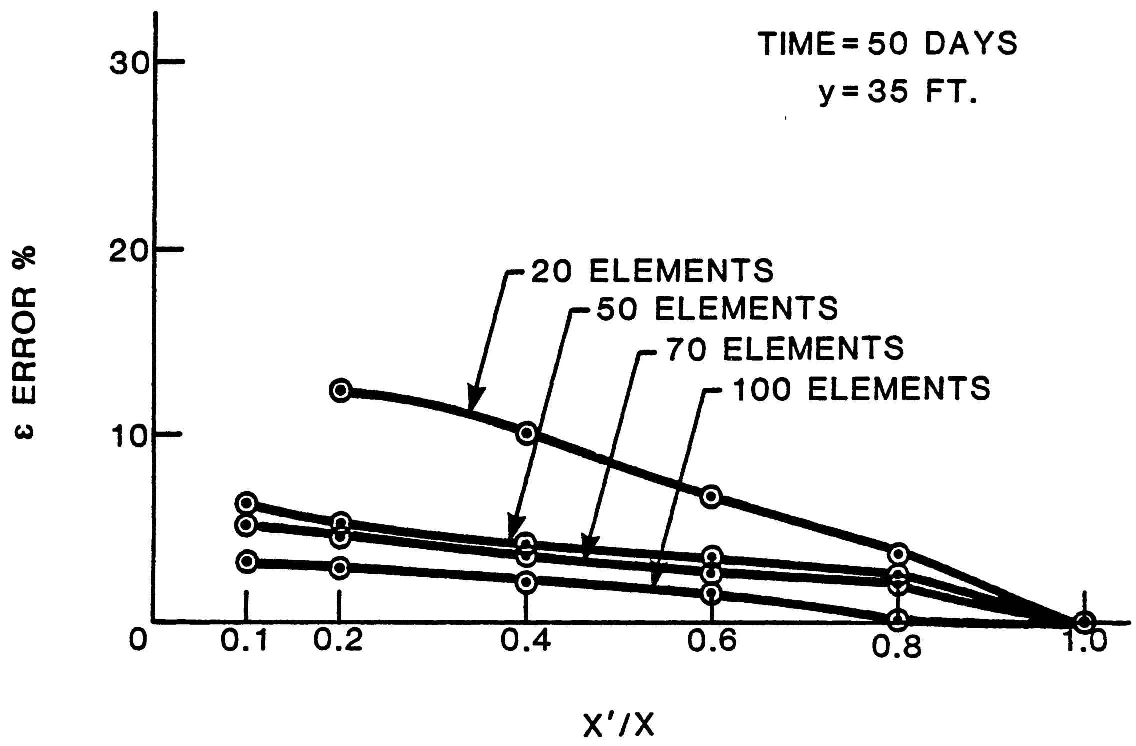


Figure 14. Error Percentage Versus x Distance at Time = 50 Days

varied from 0 to 7.2 percentage for 100 elements and 0 to 18.6 percentage for 20 elements.

Tables II and III show that with more elements and a longer period of time, the error will decrease. We also plot the figures to show the error versus the number of elements used (Figures 15 and 16). In this particular case, if we use more elements at a shorter distance from the strip source, we can get better results.

Thus, the developed model is compared against a two-dimensional analytical solution. By taking a slice in one direction, one-dimensional testing is accomplished using error analysis for different elements and times.

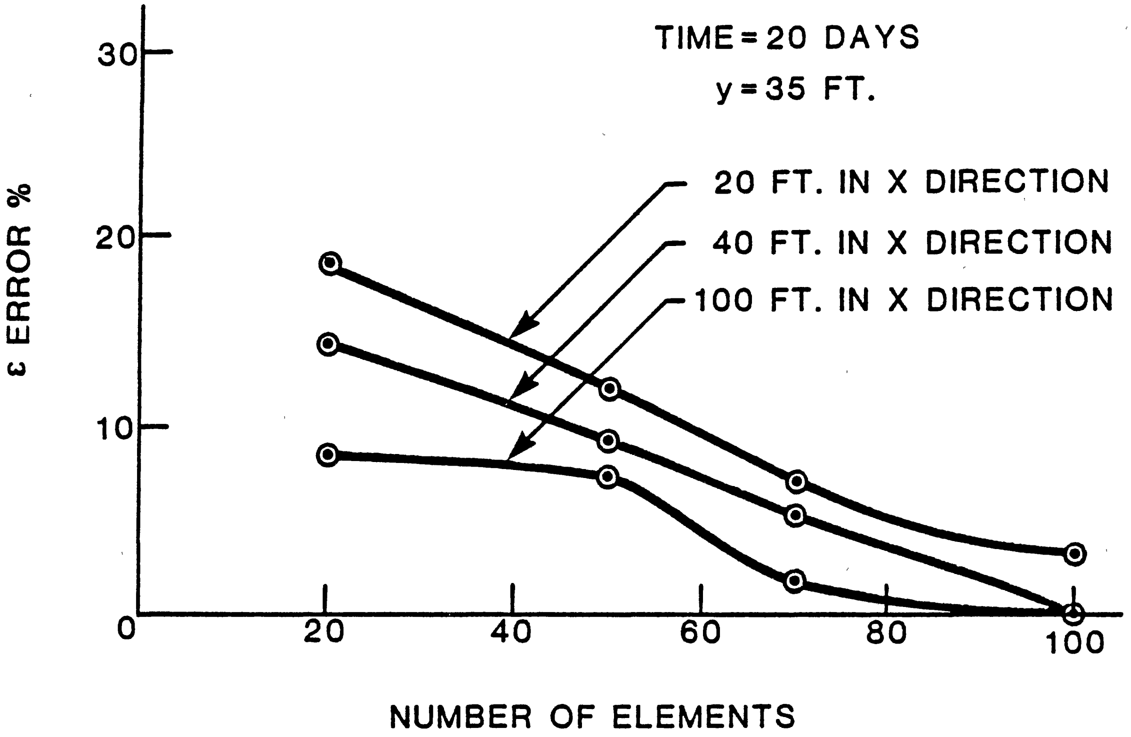


Figure 15. Error Percentage Versus No. of Elements at Time = 20 Days

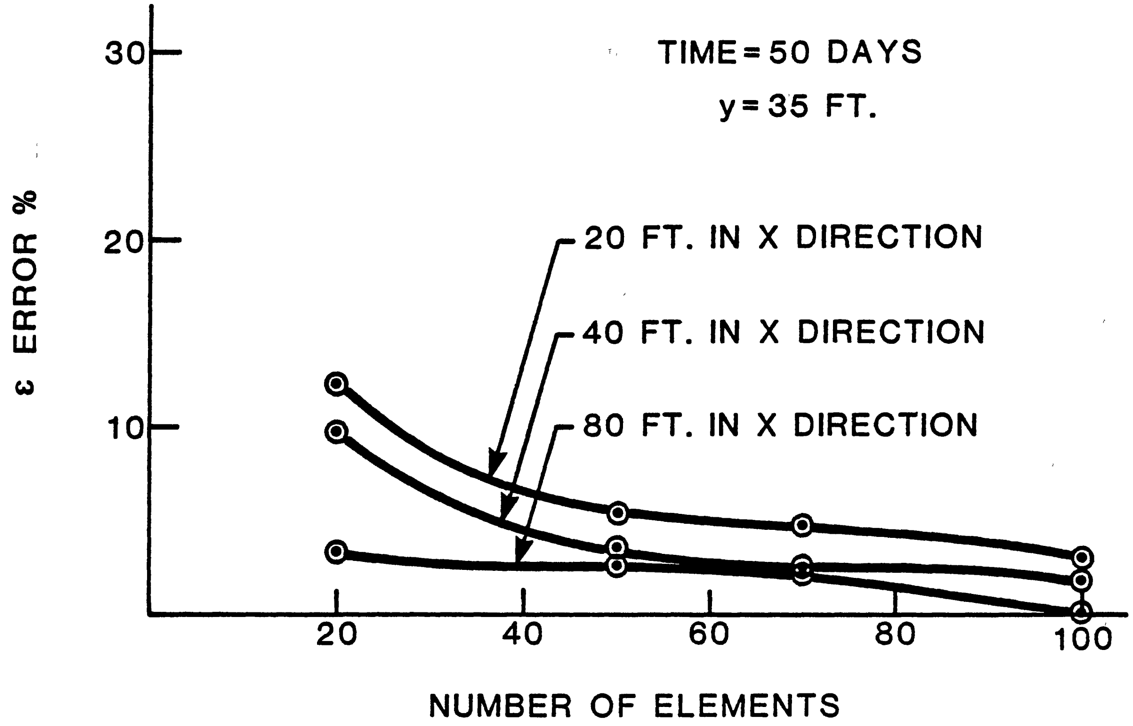


Figure 16. Error Percentage Versus No. of Elements at Time = 50 Days

CHAPTER VIII

TWO-DIMENSIONAL VALIDATION

Example Problem

The analytical solution was presented by Cleary and Ung (1978) and the numerical model was that of Gureghian et al. (1980). The developed model also was compared with an analytical solution and a numerical model. The following equation represents the water quality model:

$$\frac{\partial C}{\partial t} = D_x \frac{\partial^2 C}{\partial x^2} + D_y \frac{\partial^2 C}{\partial y^2} - V_x \frac{\partial C}{\partial x} - V_y \frac{\partial C}{\partial y} - KC \qquad (8.1)$$

The solute decay in accordance with first order kinetic K is zero in this case. The model will be subject to the following initial and boundary conditions.

$$C = C_1 \exp(-rt) \exp\{\frac{-(y - y_o)^2}{2s^2}\}; \; x = 0$$

$$\frac{\partial C}{\partial y} \longrightarrow 0; \quad y \longrightarrow +\infty$$

$$\frac{\partial C}{\partial x} \longrightarrow 0; \quad x \longrightarrow +\infty \qquad (8.2)$$

$$C = 0; \quad t = 0$$

where y_o = centered location of the Gaussian Source (L)

C_1 = peak concentration at source (ML^{-3})

s = standard deviation of Gaussian distribution source

Analytical Solution

Gureghian et al. (1980) and Cleary and Ung (1978) gave the analytical solution as follows:

$$C(x,y,t) = \frac{C_1 X s}{2\sqrt{2\pi D_x}} \exp\{\frac{V_x X}{2D_{xx}} - \frac{(y-y_o)^2}{2s^2} + \frac{s^2}{2}(\frac{V_y}{2D_{yy}} + \frac{(y-y_o)^2}{s^2})^2\}$$

$$\cdot \int_0^t \frac{\exp\{(\frac{V_x^2}{4D_{xx}} - \frac{V_y^2}{4D_{yy}})t\}}{t^{3/2}\,(D_{yy}t + \frac{s^2}{2})^{1/2}} \qquad (8.3)$$

$$\cdot \quad \exp\{\frac{-x^2}{4D_{xx}t} - \frac{(\frac{s^2 V_y}{2D_{yy}} + (y-y_o)^2)}{4(D_{xx} + 0.5s^2)}\}dt$$

where y direction is infinite, $-\infty < y < \infty$, and

x direction is semi-infinite, $0 \leq x < \infty$

The peak concentration at source C_1 = 1.0, the centered location is 400 feet, and the standard deviation is 300.

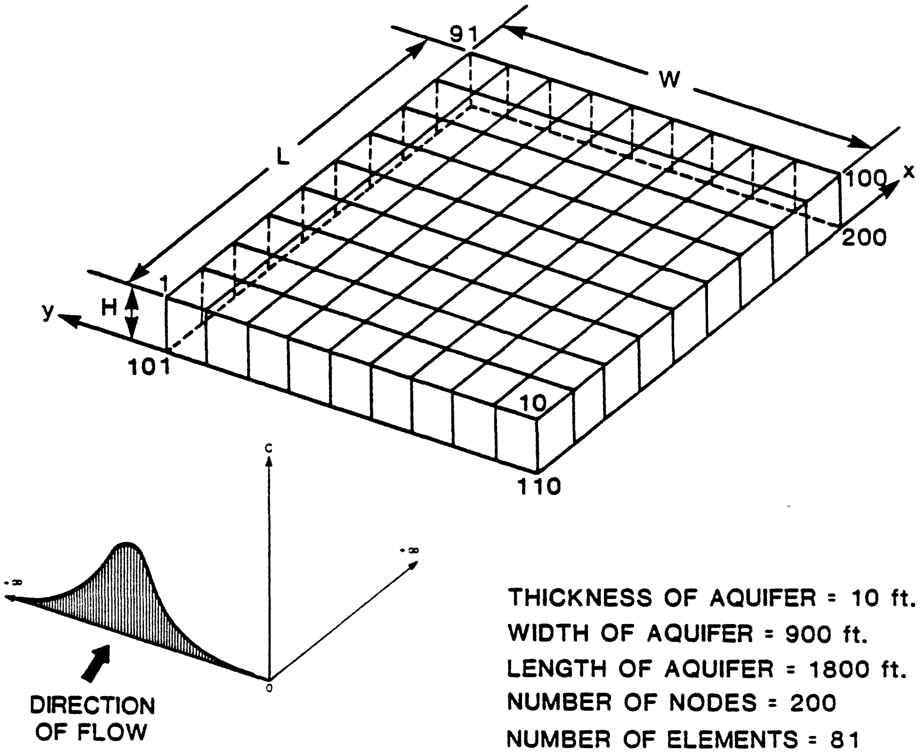
Numerical Model

In this study, the size of the aquifer is 1800 by 900 feet and the thickness of the aquifer is 10 feet. The grids used to compare the analytical solution include 81 elements, each of which measure 200 by 100 feet. Figure 17 shows the model with Gaussian distribution source.

In this test, Peclet numbers 10 and 500 are selected to do the comparison. In $P_e = V L/D$, V is the velocity, L is the characteristic length (element size), and D is the dispersion coefficient. In this study the simulation time is 175 days and the time increment is 25 days. The velocity in x direction is 4ft/day and in y direction is 1ft/day for both cases. For a Peclet number equal to 10, the dispersion coefficient is 80ft^2 in x direction and 10ft^2 in y direction. Thus, $P_e = 4x200/80$ or $P_e = 1x100/10$. For a Peclet equal to 500, dispersion coefficients in x and y directions are 1.6ft^2/day and 0.2ft^2/day respectively, P_e = 4x200/1.6 or 1x100/0.2.

Validation

Figures 18 and 19 show the computed concentrations 0.2, 0.5, and 0.8 given by the analytical solution and the finite element method. In both cases, $P_e = 10$ and $P_e = 500$. At higher concentrations, the Gureghian (1981) and the developed model are close to the analytical solution, and at lower concentrations, both show an overshoot. For $P_e = 10$, when the model's solution versus the analytical solution, the error varied from 0% to 24%. When Gureghian's (1981) solution versus analytical solution, the error varied from 0% to 38%. The two numerical model solution's errors varied



THICKNESS OF AQUIFER = 10 ft.
WIDTH OF AQUIFER = 900 ft.
LENGTH OF AQUIFER = 1800 ft.
NUMBER OF NODES = 200
NUMBER OF ELEMENTS = 81

Figure 17. Model with Gaussian Distribution Source

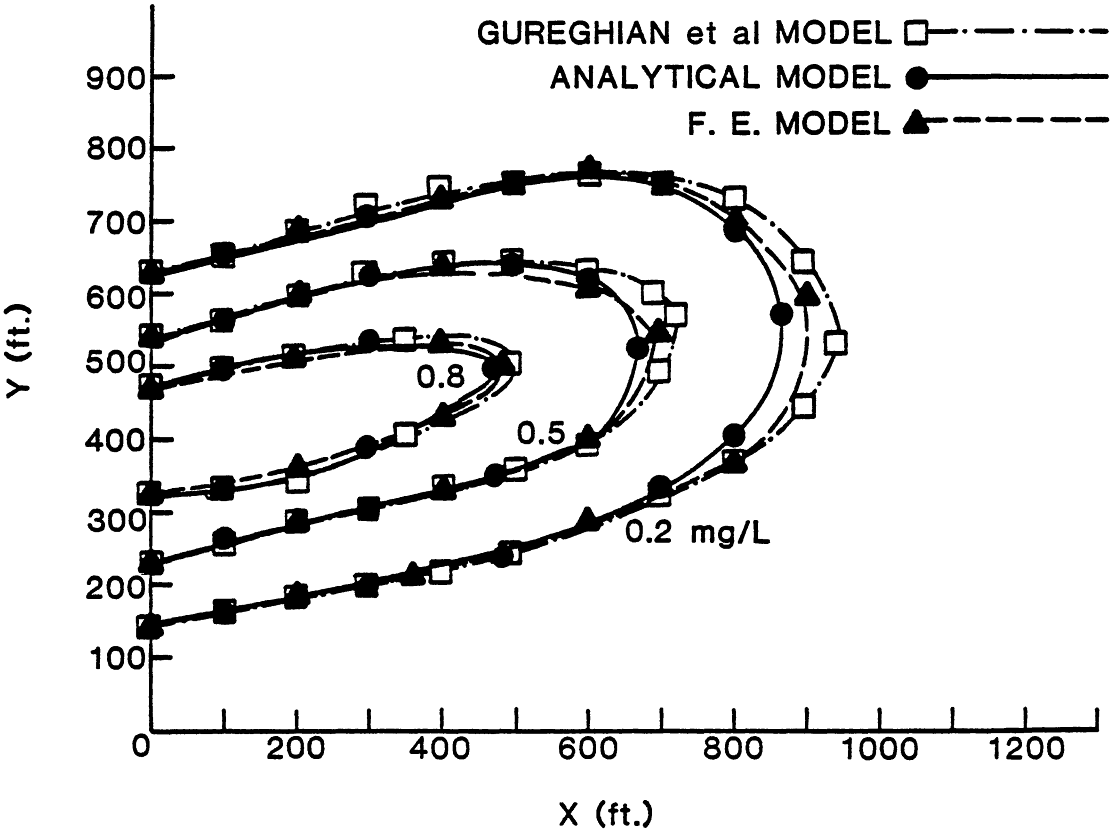


Figure 18. Concentration Variations for $P_e = 10$

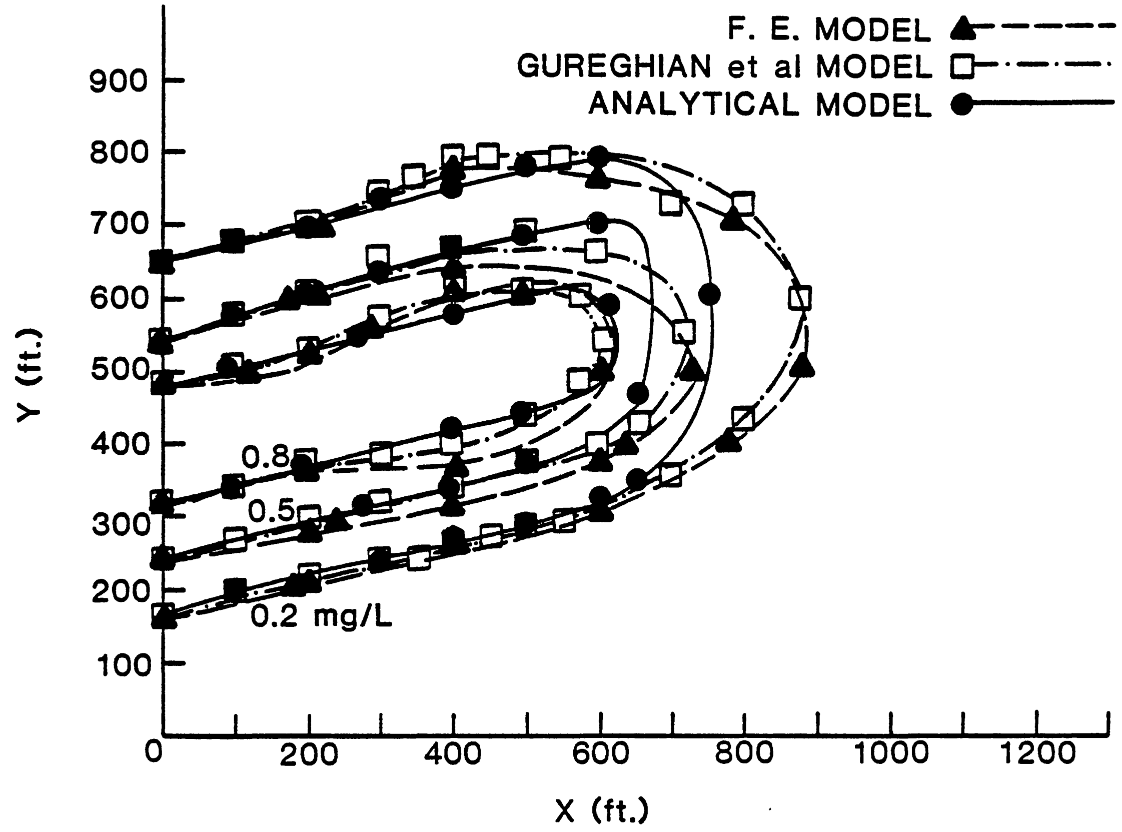


Figure 19. Concentration Variations for P_e = 500

from 0% to 12.55%. For $P_e = 500$, the error increased. When the analytical solution versus Gureghian's model's solution, error varied from 0% to 57.50%. When the developed model solution was compared with the analytical solution, the error varied from 0% to 56%. The two numerical model solution's errors varied only 1%. The error anlaysis is presented for the two-dimensional case. The error varies between 0% to 38% and 0% to 57.5% for the two solutions for only one node. For other nodes, the error for the two solutions varies between 0% to 20% and 0% to 22%. Thus, the developed model is tested against a two-dimensional solution and the numerical solution.

The numerical experiments in this study show that errors are larger for higher concentrations. For relatively low concentrations, errors become significant from 24% for low Peclet numbers (10) to 56% for high Peclet numbers (500). This perhaps caused the overshoot. Thus, the Peclet numbers should be kept relatively low where the concentrations are relatively small because the Peclet number is proportional to element size or length characteritics. The overshoot could be minimized by keeping the element size small in areas of low concentration.

CHAPTER IX

THREE-DIMENSIONAL VALIDATION

Example Problem

Not very many numerical solutions for three-dimensional testing have been developed. The AT123D Program developed by Yeh (1981) has been used to compare with the model developed in this study. He computed the spatio-temporal distribution of waste in the aquifer system. In his search for a closed-form solution, the application of Green's function is utilized to the optimum advantage. The following equation is established by Duguid and Reeves (1976) and Yeh (1981).

$$R_d \frac{\partial n_e C}{\partial t} = \nabla \cdot (n_e D \nabla C) - \nabla \cdot CV + \dot{M} - K n_e R_d C - \lambda n_e R_d C \qquad (9.1)$$

$$S = K_d C \qquad (9.2)$$

where $\dot{M}$ = rate of source ($ML^{-3}T^{-1}$)

K = distribution coefficient

ρ = bulk density of the media (ML^{-3})

$R_d = 1 + \frac{\rho K_d}{n_e}$ retardation factor

The other terms are the same as equation (4.1), thus allowing for comparison with the developed model. All the parameters should divide by the retardation factor. In this testing, velocity is $0.48x10^{-5}m^{2}/hr$; dispersion coefficients are $7.439x10^{-5}m^{2}/hr$, $1.24x10^{-4}m^{2}/hr$, and $1.240x10^{-4}m^{2}/hr$ in x, y, z directions respectively. The retardation decay constant is .00000283 curie/hr. The two cases studied are the point source in x, y, z directions (0, 10,1) and the line source in x, y, z directions. Both cases are finite width and finite depth (Figure 20).

Analytical Solution

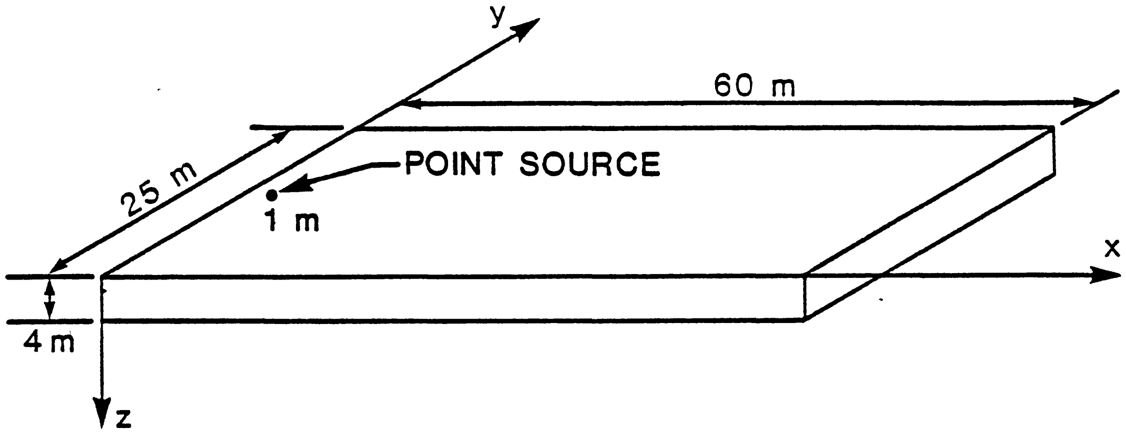
Various mathematical techniques can be applied to finding the analytical solutions. In the AT123D program, Green's function (Yeh, 1981) is used.

The initial condition is described as:

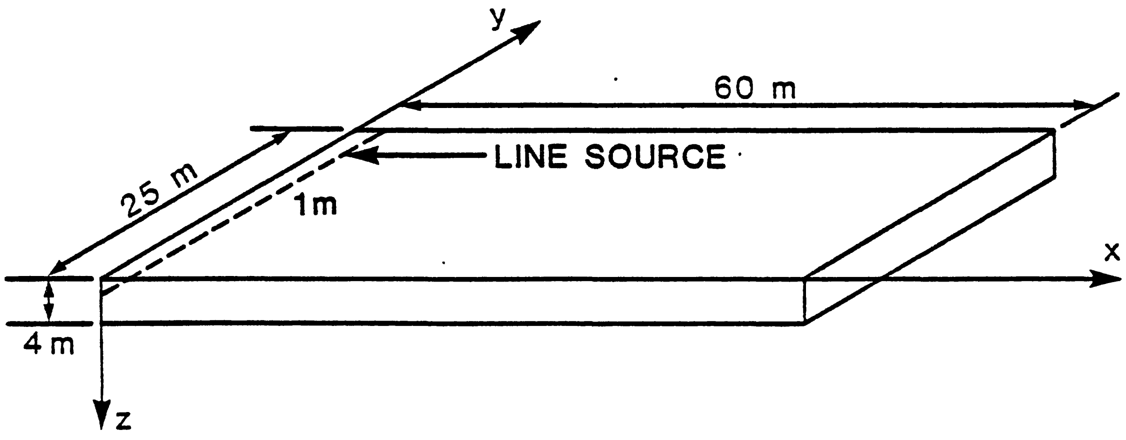
$$C = C_0(x,y,z,0), \text{ at } t = 0 \text{ and in } R \tag{9.3}$$

where C_0 is a given function of spatial coordinates x, y, and z; R is a region bounded by the curve, and $B(x,y,z) = 0$ as shown in Figure 21. This C_0 may also be obtained by simulating the steady-state version of equation (9.1) with steady boundary conditions and groundwater flow field. Three types of boundary conditions may be specified depending on the physical constraints. The first type of boundary condition is the Dirichlet, and the concentration prescribed is

$$C = C_1(x,y,z,t) \text{ on } B_1 \tag{9.4}$$

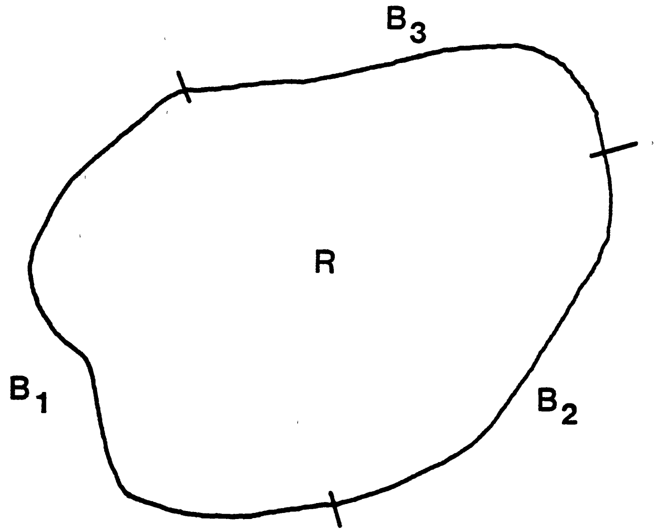


CASE 1 POINT SOURCE (0, 10, 1)



CASE 2 LINE SOURCE $(x_s, y_s, z_s) = (0, 0, 1)$
$(x_s, y_s, z_s) = (0, 25, 1)$

Figure 20. Schematization of Source Dimensions and the Medium



$$B = B_1 \cup B_2 \cup B_3$$

Figure 21. Spatial Boundary of Region R

where B_1 is a portion of B and C_1 is a given function of time and the location on B_1. The second type of boundary condition and the normal gradient of the concentration is described as

$$-n_e D \cdot \nabla\ C \cdot \vec{n} = q_2(x,y,z,t) \text{ on } B_2 \tag{9.5}$$

where $\vec{n}$ is the directional cosine of the outward unit vector normal to the B_2 portion of the curve B.

The third type is the Cauchy boundary condition. It is applied to the flow-through boundaries with inflows into the region and is written as

$$-(n_e D \cdot \nabla C - VC)\vec{n} = q_3(x,y,z,t) \text{ on } B_3 \tag{9.6}$$

where q_3 is a given function of time and the points (x,y,z) are on the B_3 portion of B.

The solution of equation (9.1), subject to initial and boundary conditions, is

$$C(x,y,z,t) = \int_0^t \int_R \frac{\dot{M}}{n_e R_d} G dR_o d\tau + \int_R (GC_o)_{\tau = o} dR$$

$$- \int_0^t \int_R D \cdot \nabla G \cdot \vec{n} C_1 dB_0\ d\tau - \int_0^t \int_{B_2} \frac{Gq_2}{n_e R_d} dB_0 d\tau \tag{9.7}$$

$$- \int_0^t \int_{B_3} \frac{Gq_2}{n_e R_d} dB_0 d\tau$$

If G(x,y,z; α, β, r) satisfy the following conditions:

$$\lim_{t\to\tau} G = \delta(x-\alpha)\delta(y-\beta)\delta(z-r) \tag{9.8}$$

$$G = 0 \quad \text{for } t < \tau \tag{9.9}$$

$$G = 0 \quad \text{on } B_1 \tag{9.10}$$

$$(n_e D\cdot\nabla_0 G + \vec{V}G)\cdot\vec{n} = 0 \quad \text{on } B_2 \tag{9.11}$$

$$n_e D\cdot\nabla_0 G\cdot\vec{n} = 0 \quad \text{on } B_3 \tag{9.12}$$

$$-\partial G/\partial t = \nabla_0\cdot(K\cdot\nabla_0 G) + V\cdot\nabla G$$

$$- (K/R_d + \lambda)G \text{ for } t > \tau \tag{9.13}$$

where ∇_0: Del operator with respect to $\alpha,\beta.r$. The subscript '0' in equations (9.7) through (9.13) refers to the operation with respect to α,β,r rather than x,y,z. G is Green's function. If G is known,the problem is solved. It can be shown with simple geometry such as a separable coordinate system. Green's function may be expressed as

$$G(x,y,z,t;\alpha,\beta,\tau)=G_1(x,t;\alpha,\tau)G_2(y,t;\beta,\tau)G_3(z,t;r,\tau) \tag{9.14}$$

The derivation of G_1, G_2, G_3 can be found elsewhere (Fried, 1975) and Yeh and Tsai, 1976). If we further assume that no waste can flow across the impervious boundaries and the flows through open boundaries are located at infinity, then we obtain $C = 0$, $q_2 = 0$, and $q_3 = 0$. For a continuous source, equation (9.7) reduces to

$$C(x,y,z,t) = \int_0^t \frac{\dot{M}}{n_e R_d} F_{ijk}(x,y,z,t;\tau)d\tau;\ t < T \qquad (9.15)$$

and

$$C(x,y,z,t) = \int_0^T \frac{\dot{M}}{n_e R_d} F_{ijk}(x,y,z,t;\tau)d\tau;\ t > T \qquad (9.16)$$

for F_{ijk} is the integral of Green's function (G) over the source space and T is the duration of waste release. F_{ijk} is given by

$$F_{ijk} = X_i Y_j Z_k \qquad (9.17)$$

where i = 1 or 2, j = 1 or 2, and k = 1 or 2, functions X_i Y_j, and Z_k are given as follows.

For a point source:

In X direction:

$$X_1 = \frac{1}{\sqrt{4\pi D_{xx}(t-\tau)}}\exp[\frac{-\{(x-x_s)-V(t-\tau)\}^2}{4D_{xx}(t-\tau)} - (\frac{K}{R_d}+\lambda)(t-\tau)\} \qquad (9.18)$$

In Y direction:

$$Y_1 = \frac{1}{B} + \frac{2}{B}\sum_{i=1}^{\infty} \cos(\frac{i\pi y}{B})\cdot\cos(\frac{i\pi y_s}{B})\cdot\exp\{-(\frac{i\pi^2}{B})D_{yy}(t-\tau)\} \qquad (9.19)$$

In Z direction:

$$Z_1 = \sum_{i=1}^{\infty} \Psi_i(z)\Psi_i(Z_s)\cdot\exp\{-k_i^2\ K_{zz}(t-\tau)\} \qquad (9.20)$$

For finite width and line source:

In X direction:

$$X_2 = 0.5[\mathrm{erf}\{\frac{x-L_1-V(t-\tau)}{\sqrt{4D_{xx}(t-\tau)}}\} - \mathrm{erf}\{\frac{x-L_2\ -V(t-\tau)}{\sqrt{4D_{zz}\ (t-\tau)}}\}]$$

$$\cdot\exp\{-(\frac{D}{R_d} + \lambda)(t-\tau)\} \qquad (9.21)$$

In Y direction:

$$Y_2 = \frac{B_2-B_1}{B} + \frac{2}{B}\sum_{i=1}^{\propto} \cos(\frac{i\pi y}{B})\cdot\frac{B}{if}\{\sin(\frac{i\pi B_2}{B})\sin(\frac{i\pi B_1}{B})\}$$

$$\exp\{-(\frac{i\pi 2}{3})\ D_{yy}(t-\tau)\} \qquad (9.22)$$

In Z direction:

$$Z_2 = \sum_{i=1}^{\propto} \Psi_i(Z)(\frac{a_i}{K_i})\{\sin(k_iH_2)-\sin(k_iH_1)\}$$

$$\cdot\ \exp\{-K_i^2 2D_{zz}(t-\tau)\} \qquad (9.23)$$

where B and H are the width and depth ofthe aquifer, L_1, B_1, H_1, and L_2, B_2, and H_2 are the beginning x, y, z and ending x, y, z coordinates of the source; x_s, y_s, and z_s are the x, y, z coordinates of the point sources.

$$\Psi_1(z) = a_i\cos(k_iz) \qquad (9.24)$$

and

$$a = 2/H \qquad (9.25)$$

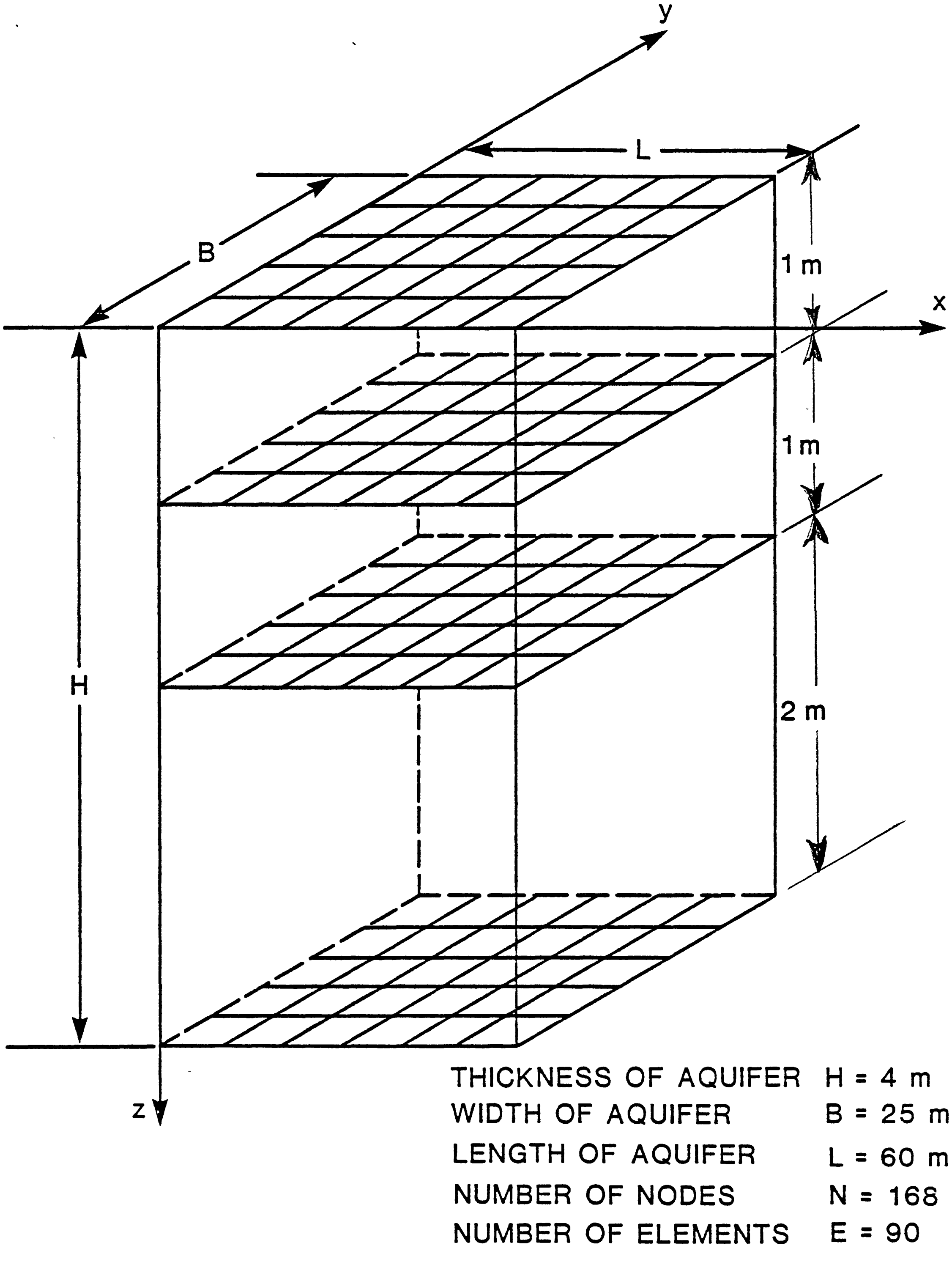
Numerical Model

The developed model uses the same parameters as those used in the example problem. The thickness of the aquifer is 4m, the width is 25m, and the length is 60m. The aquifer shown in Figure 22 is discretized into 90 elements and consists of 168 nodes.

In Case 1, the point source study, the concentration distribution of the continuous release of radioactive waste has a rate of 1.0 Ci/hr and lasts for 240 hours. A point source configuration is assumed for the radioactive waste, which is discharged into a three-dimensional porous medium of size 60 x 25 x 4 meters. Initially, no radioactivity is present in the porous medium 0. Case 2 has the same input parameters as Case 1, but uses a line source instead of a point source at a depth of 1 meter in the yz plane (Figure 23).

Validation

The error analyses of different nodes and times for both cases are listed in Tables IV to XXXIV (Appendix G). Figure 23 shows the diagram of the error analysis at plane 1, plane 2, and plane 3, located at 5m, 10m, and 20m, with depth at 1m, 2m, and 4m. Figures 24 through 41 show the error with distance in x direction for vertical planes



THICKNESS OF AQUIFER H = 4 m
WIDTH OF AQUIFER B = 25 m
LENGTH OF AQUIFER L = 60 m
NUMBER OF NODES N = 168
NUMBER OF ELEMENTS E = 90

Figure 22. Three-Dimensional Testing Model

CASE 1 AND CASE 2

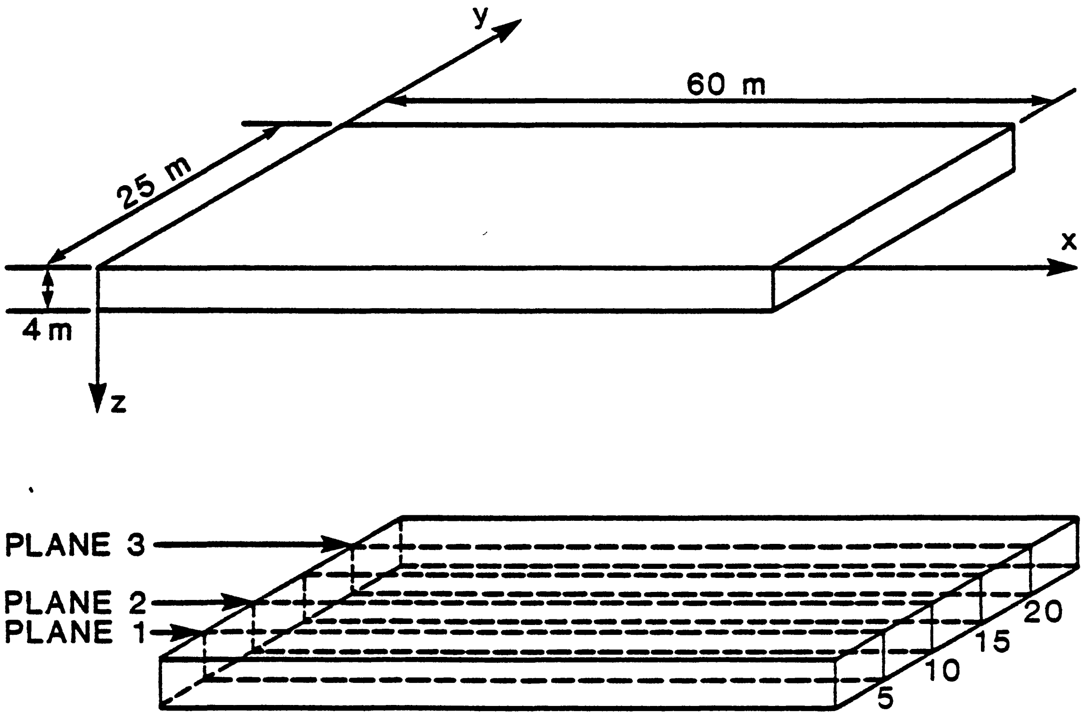


Figure 23. Schematic Diagram for Error Analysis and Comparison of Three-Dimensional and Analytical Solutions

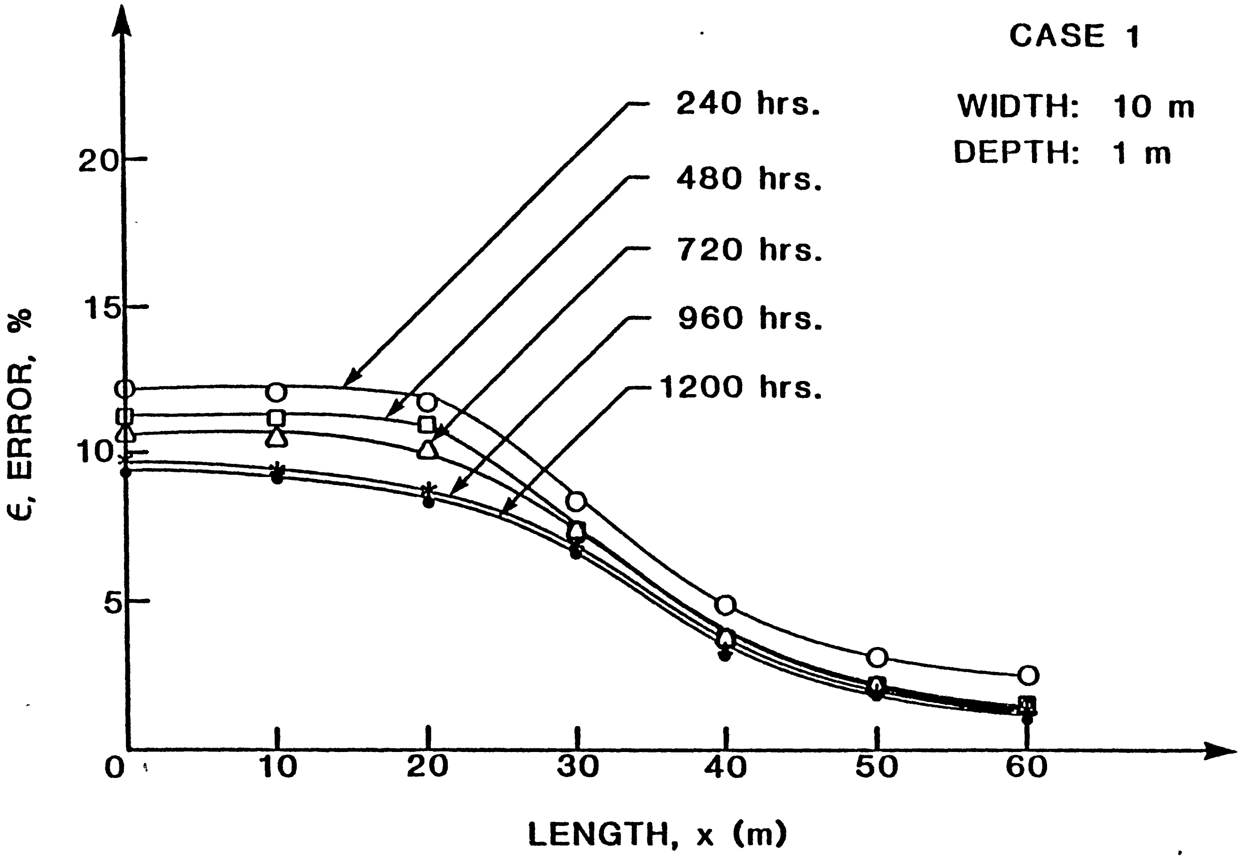


Figure 24. Error with Distance in x Direction for a Vertical Plane of 10 and 1 Meters in y and z Directions

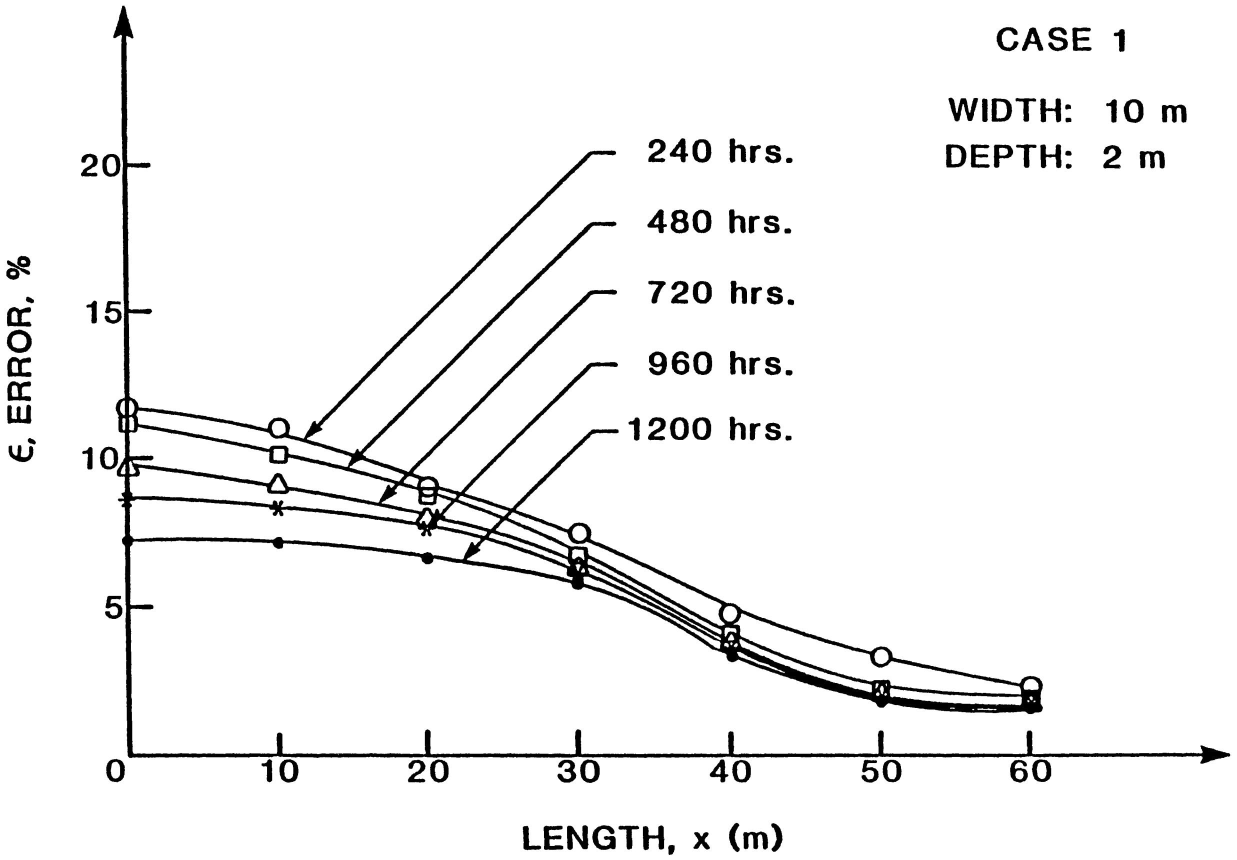


Figure 25. Error with Distance in x Direction for a Vertical Plane of 10 and 2 Meters in y and z Directions

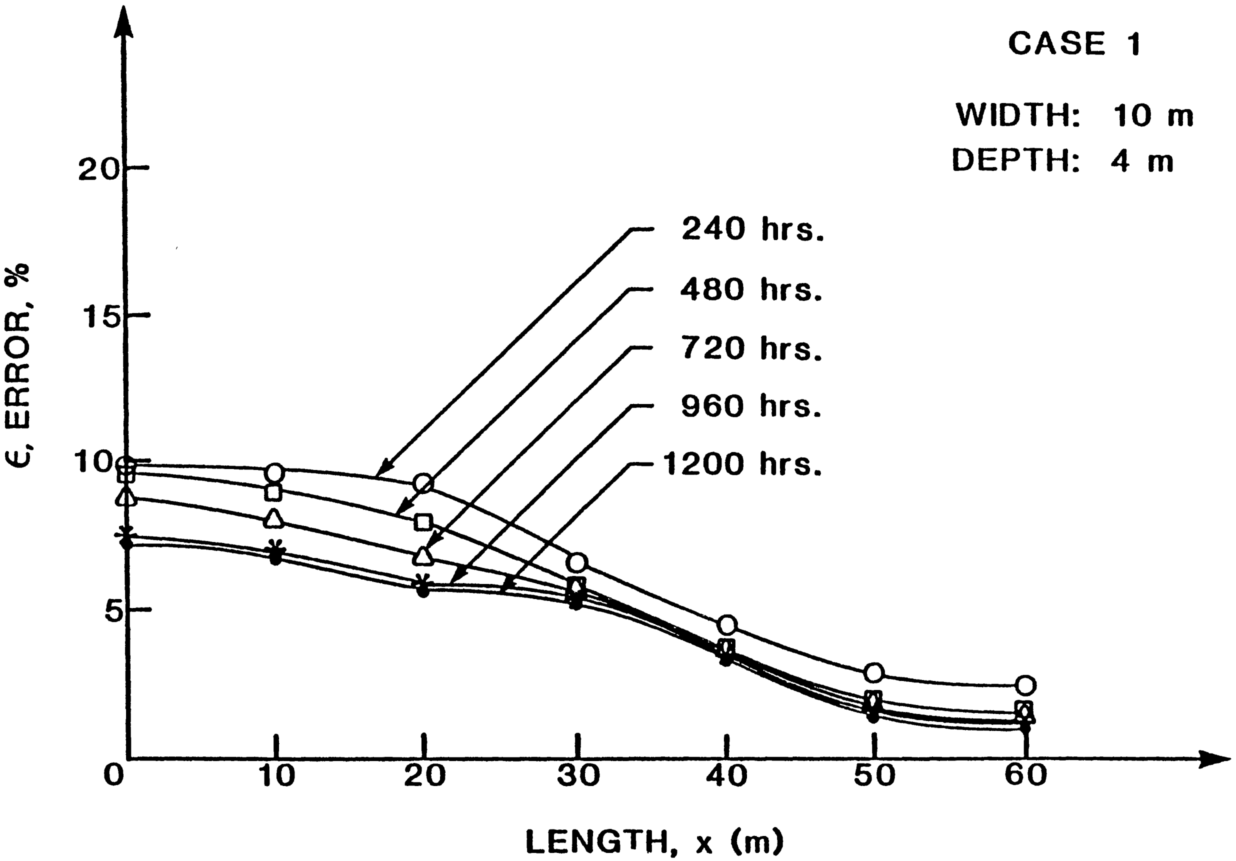


Figure 26. Error with Distance in x Direction for a Vertical Plane of 10 and 4 Meters in y and z Directions

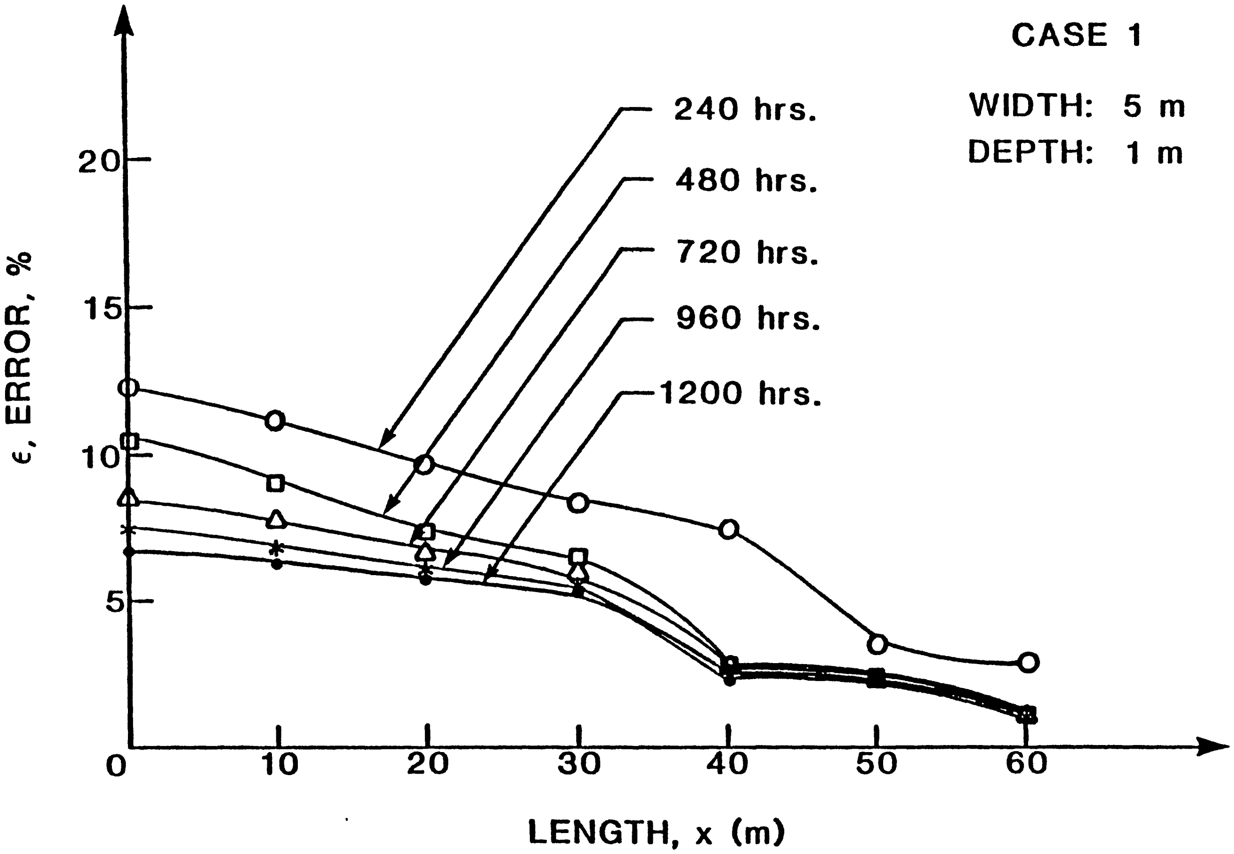


Figure 27. Error with Distance in x Direction for a Vertical Plane of 5 and 1 Meters in y and z Directions

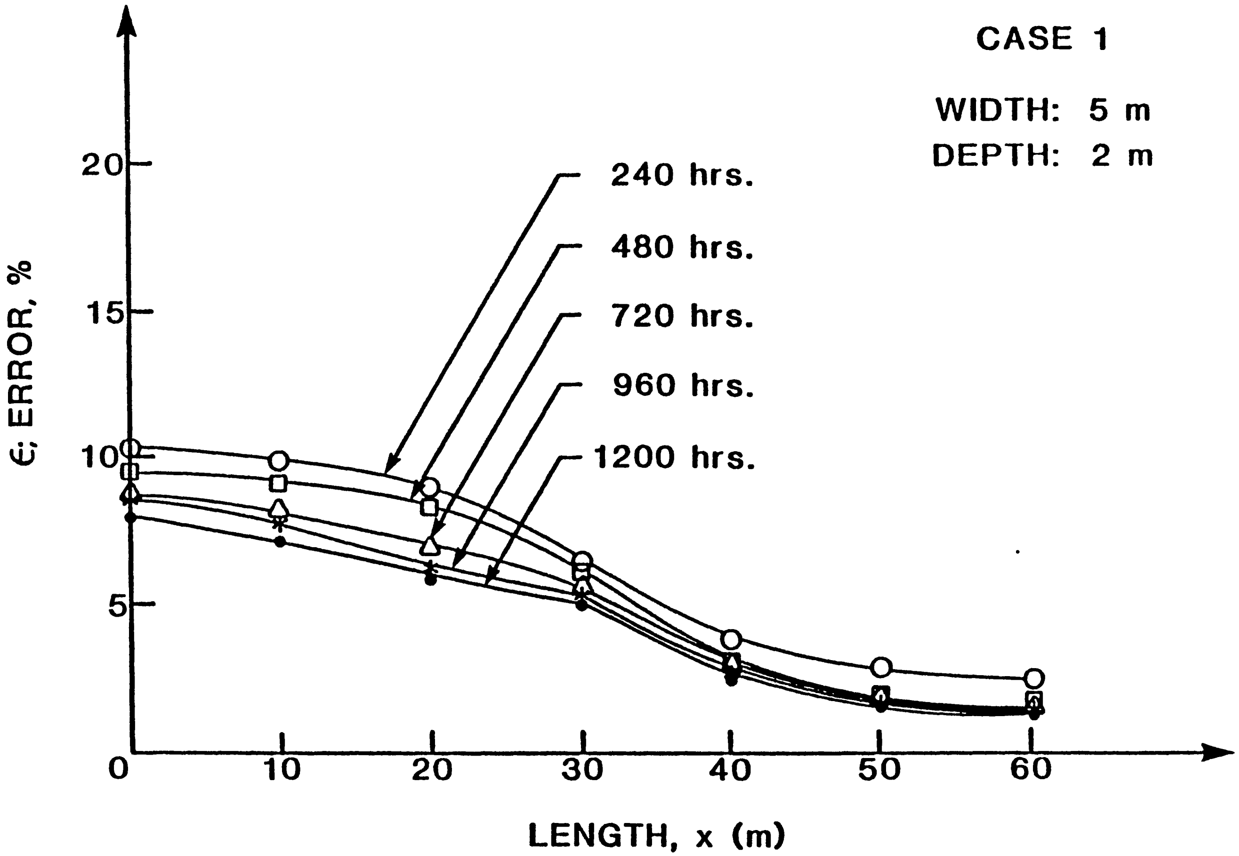


Figure 28. Error with Distance in x Direction for a Vertical Plane of 5 and 2 Meters in y and z Directions

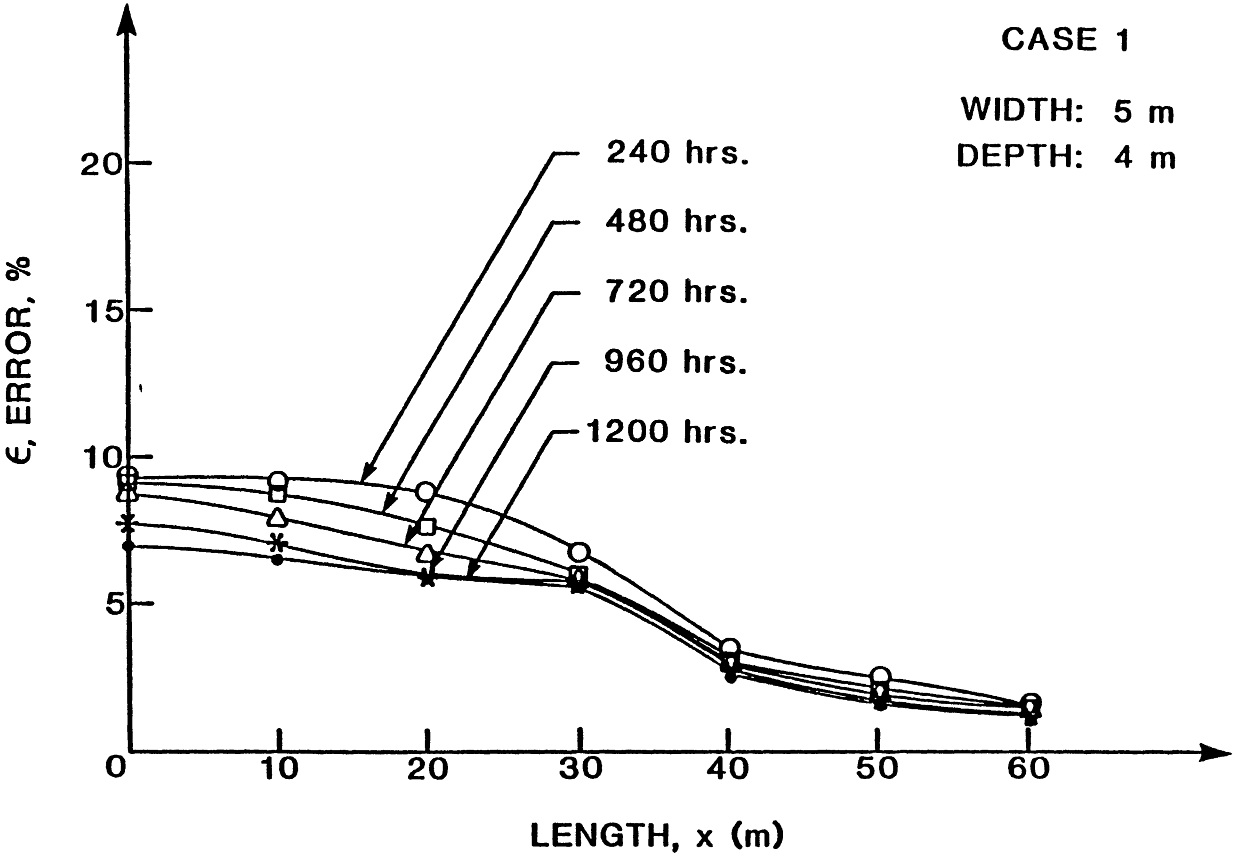


Figure 29. Error with Distance in x Direction for a Vertical Plane of 5 and 4 Meters in y and z Directions

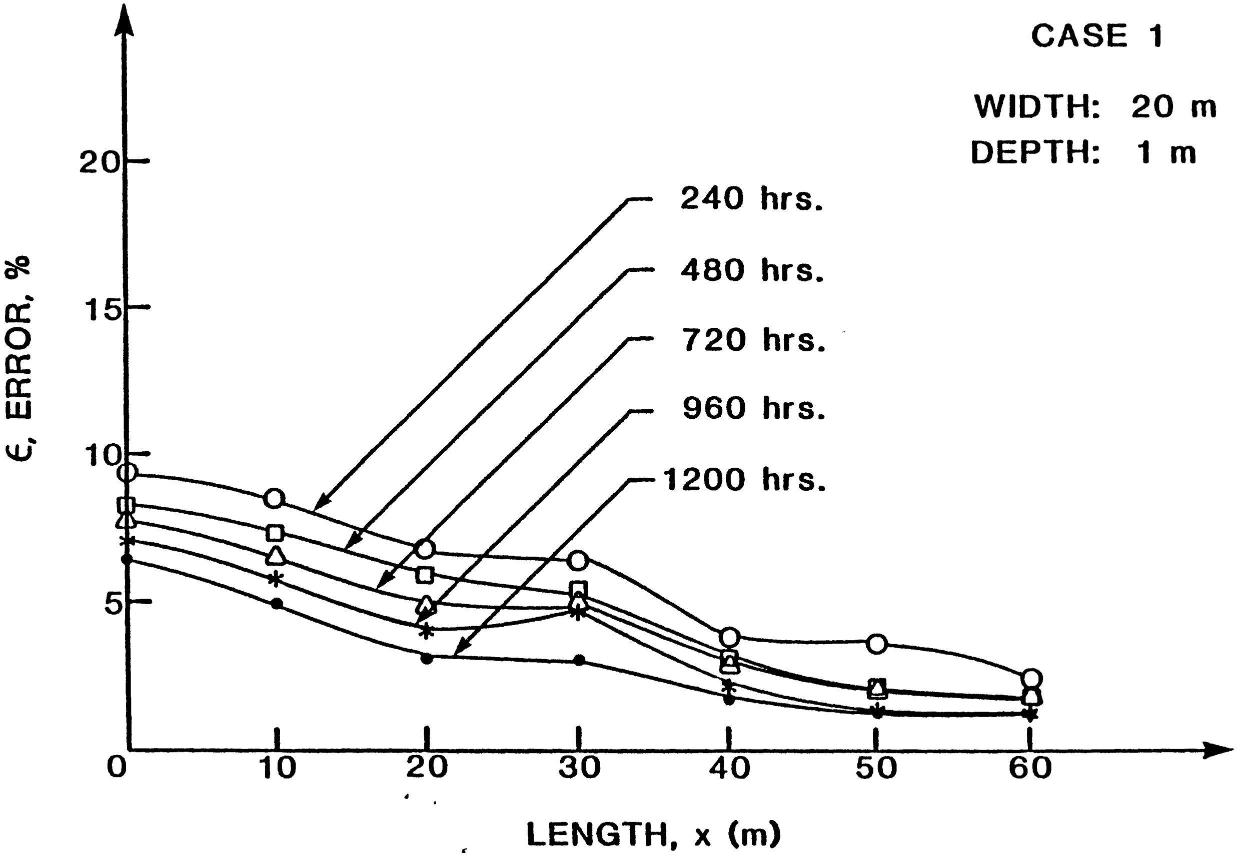


Figure 30. Error with Distance in x Direction for a Vertical Plane of 20 and 1 Meters in y and z Directions

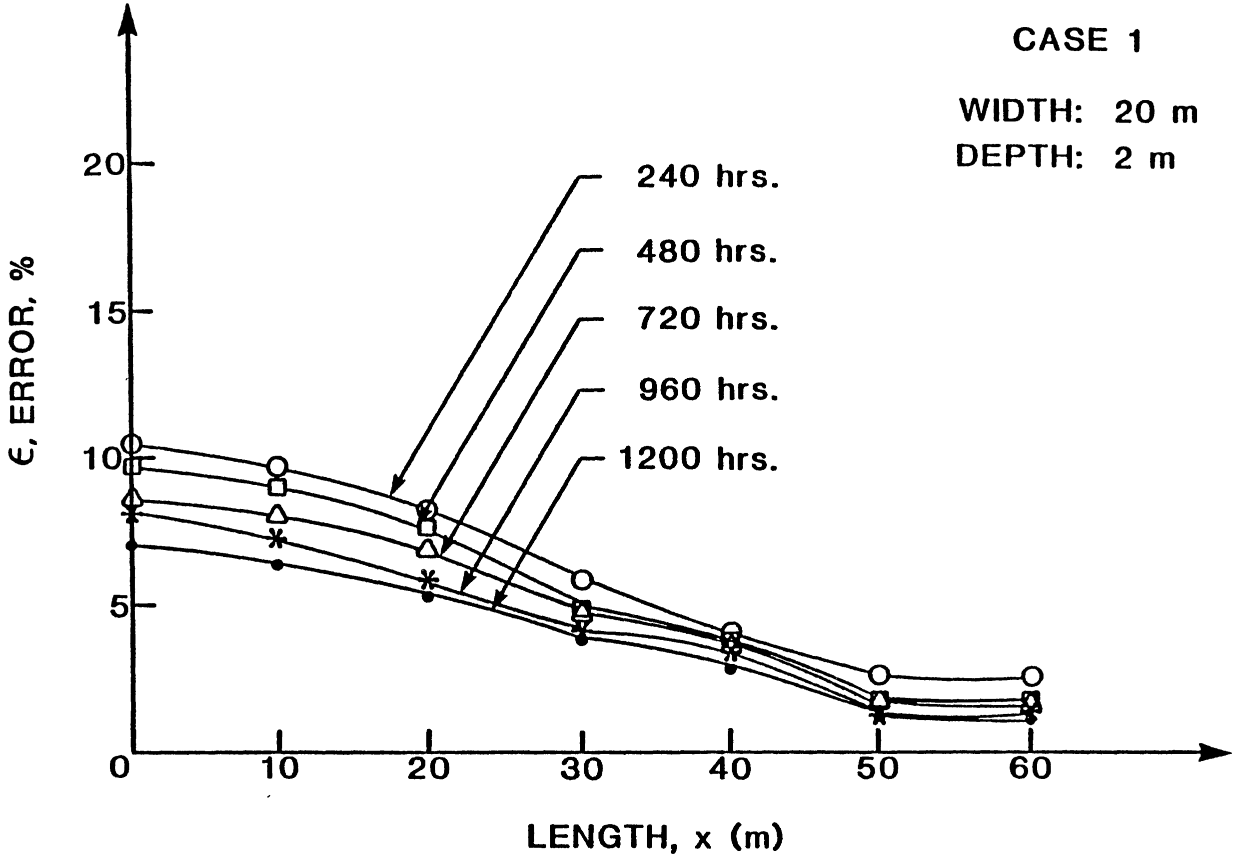


Figure 31. Error with Distance in x Direction for a Vertical Plane of 20 and 2 Meters in y and z Directions

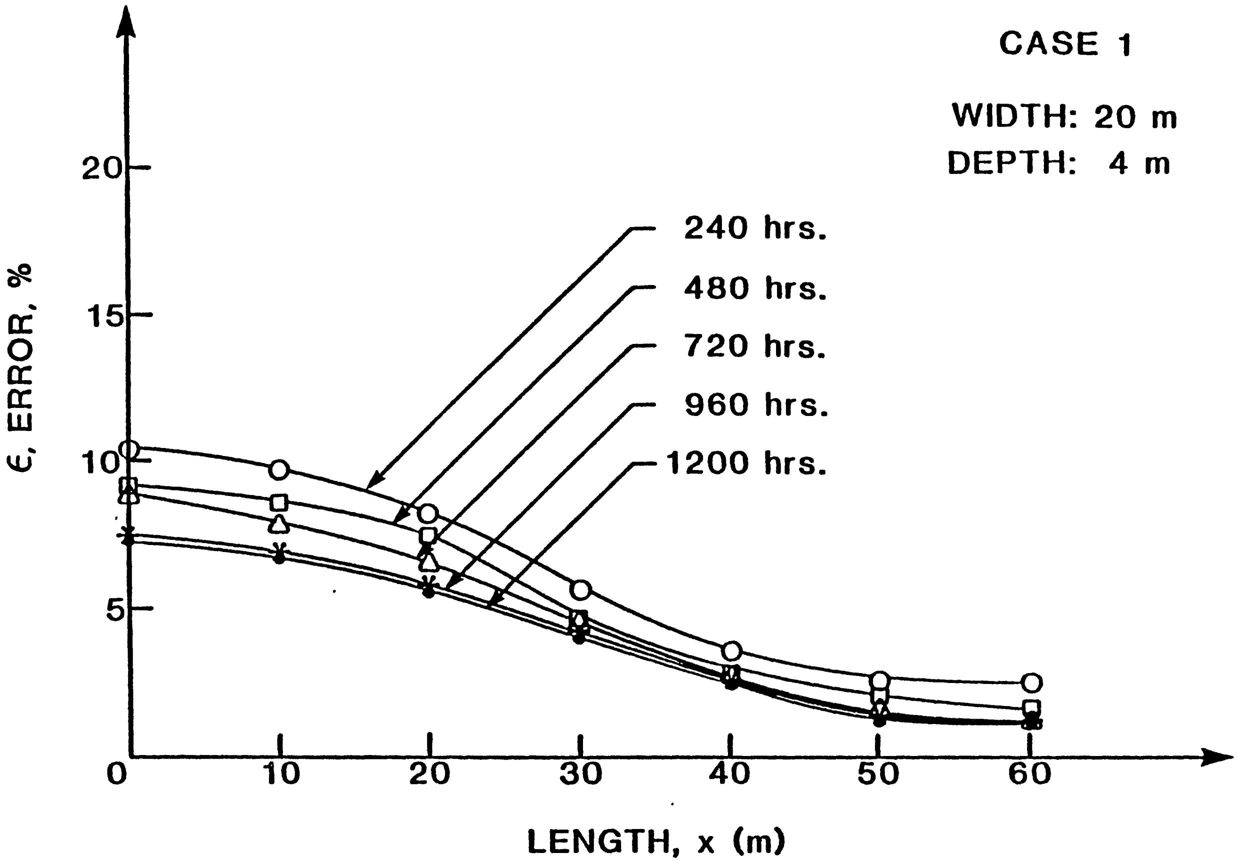


Figure 32. Error with Distance in x Direction for a Vertical Plane of 20 and 4 Meters in y and z Directions

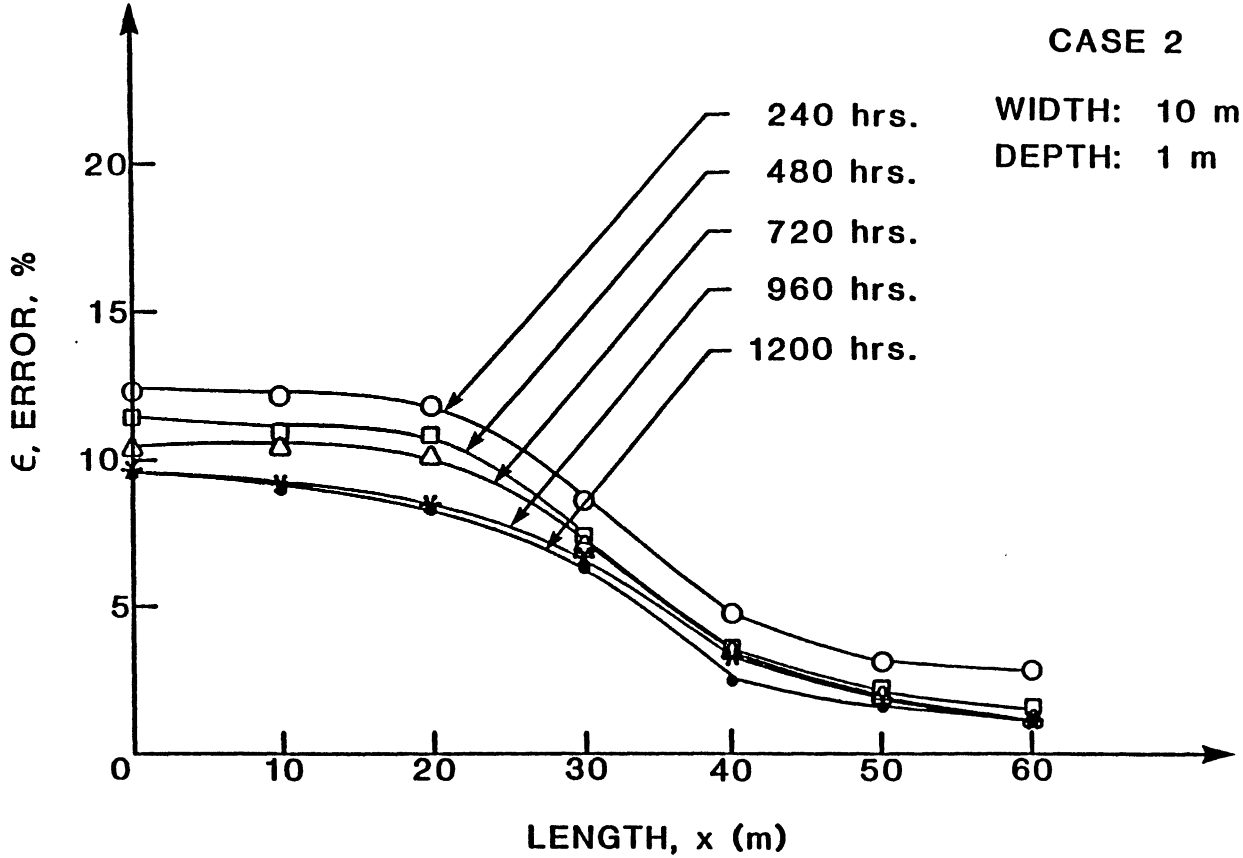


Figure 33. Error with Distance in x Direction for a Vertical Plane of 10 and 1 Meters in y and z Directions

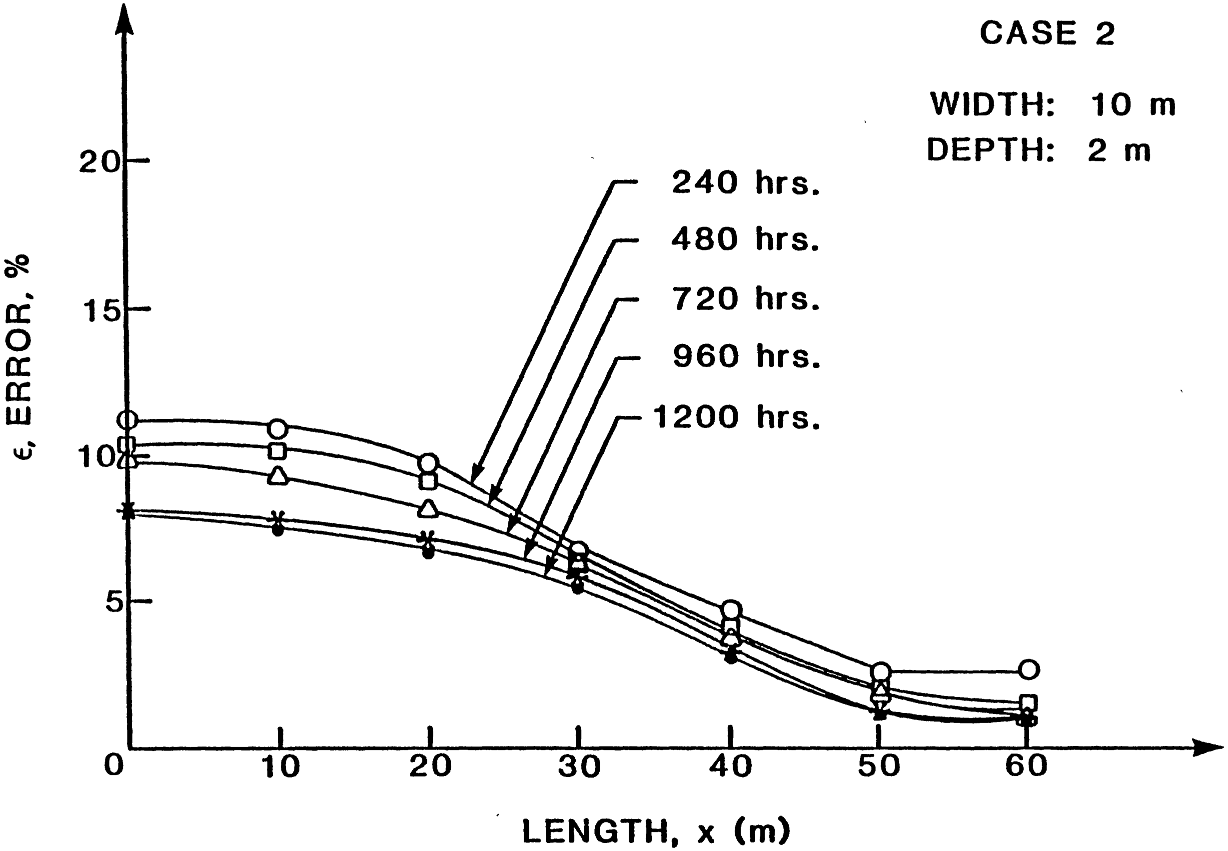


Figure 34. Error with Distance in x Direction for a Vertical Plane of 10 and 2 Meters in y and z Directions

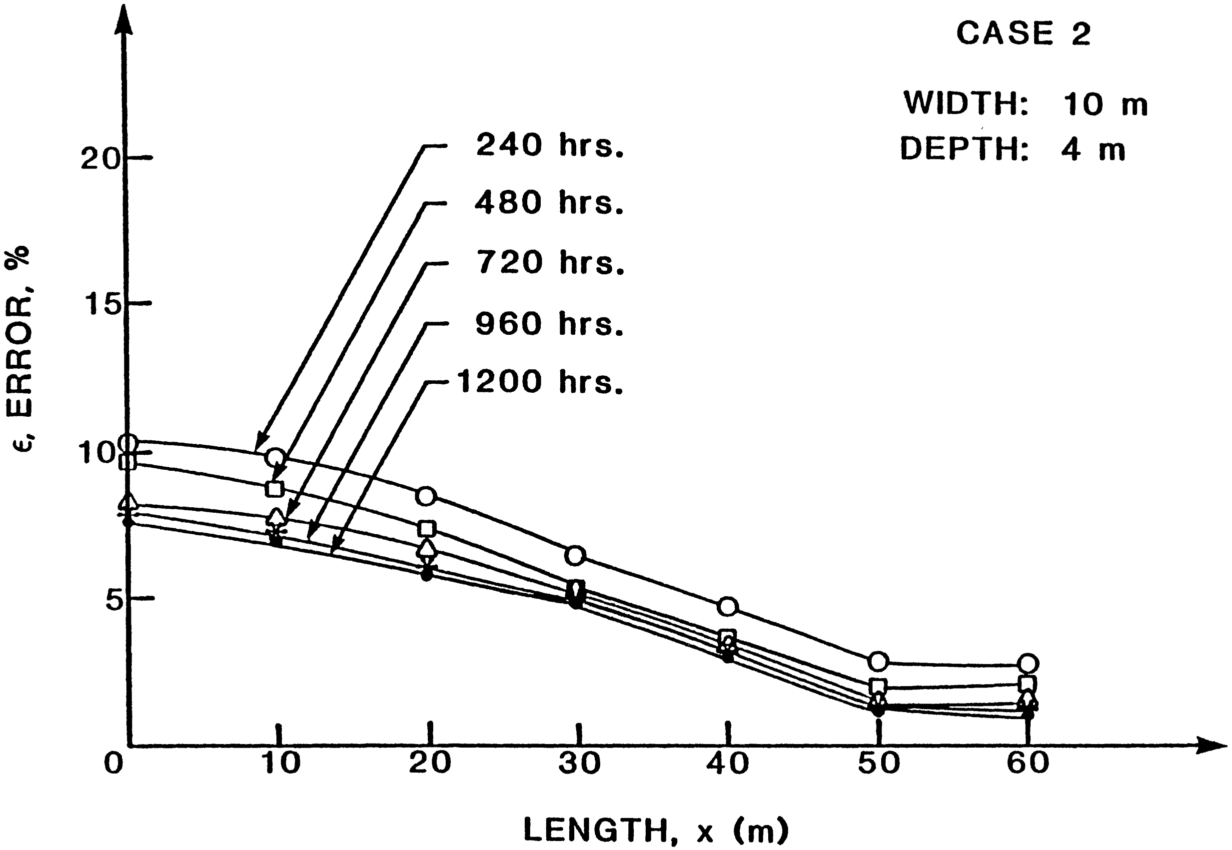


Figure 35. Error with Distance in x Direction for a Vertical Plane of 10 and 4 Meters in y and z Directions

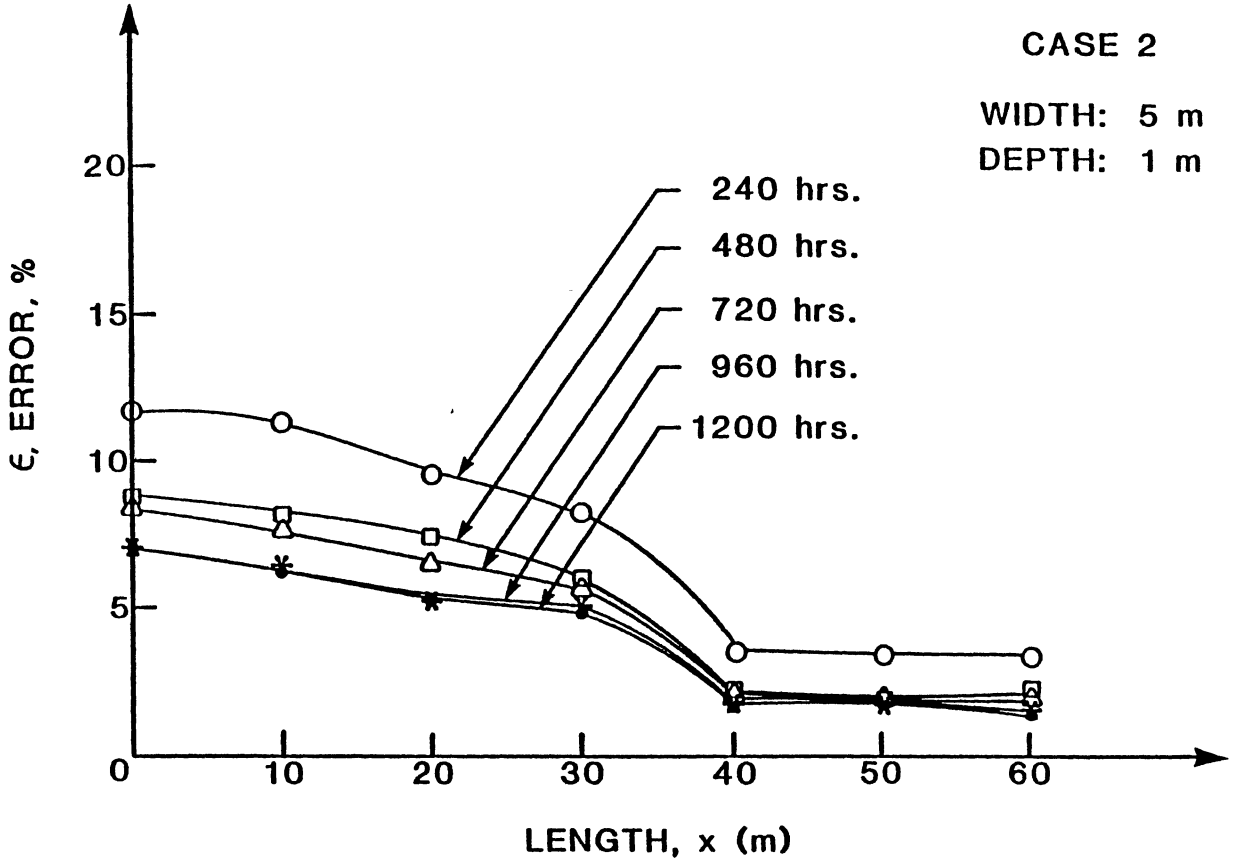


Figure 36. Error with Distance in x Direction for a Vertical Plane of 5 and 1 Meters in y and z Directions

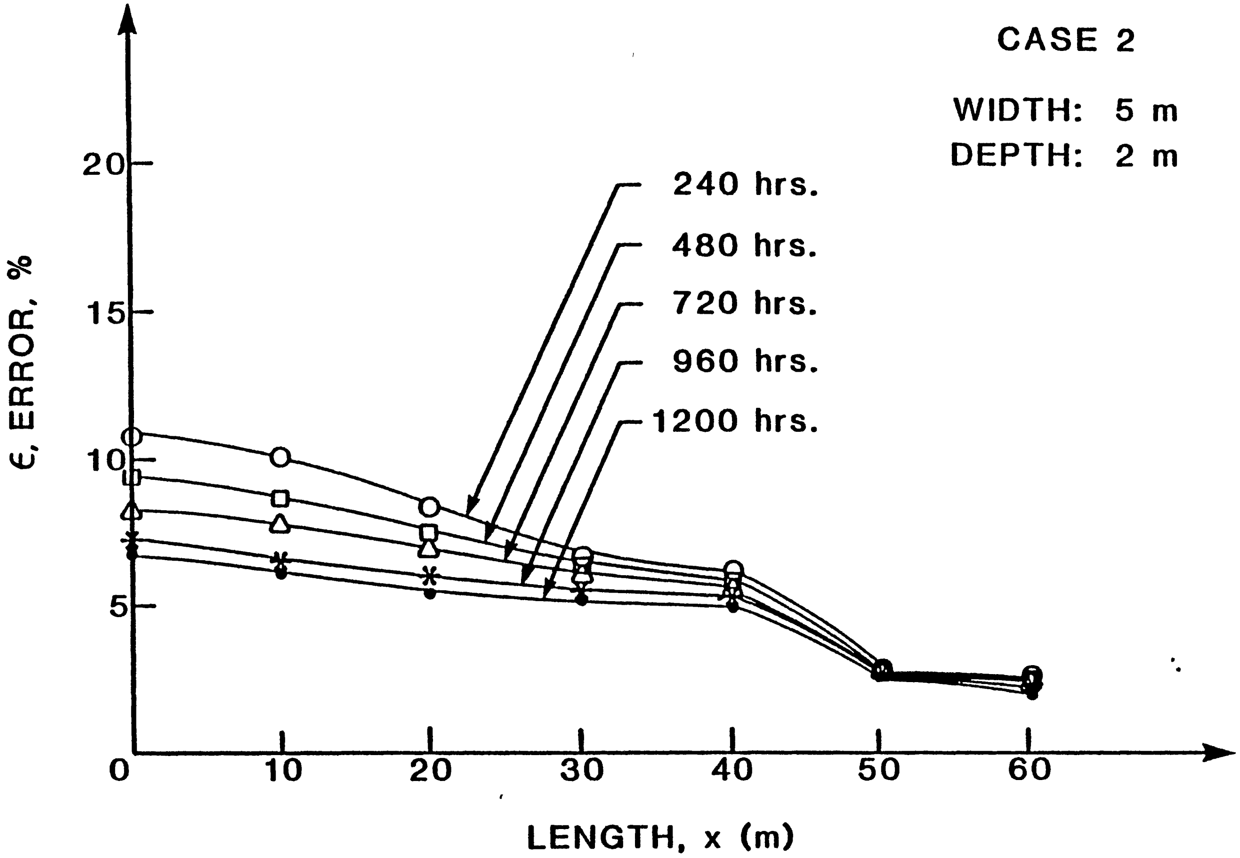


Figure 37. Error with Distance in x Direction for a Vertical Plane of 5 and 2 Meters in y and z Directions

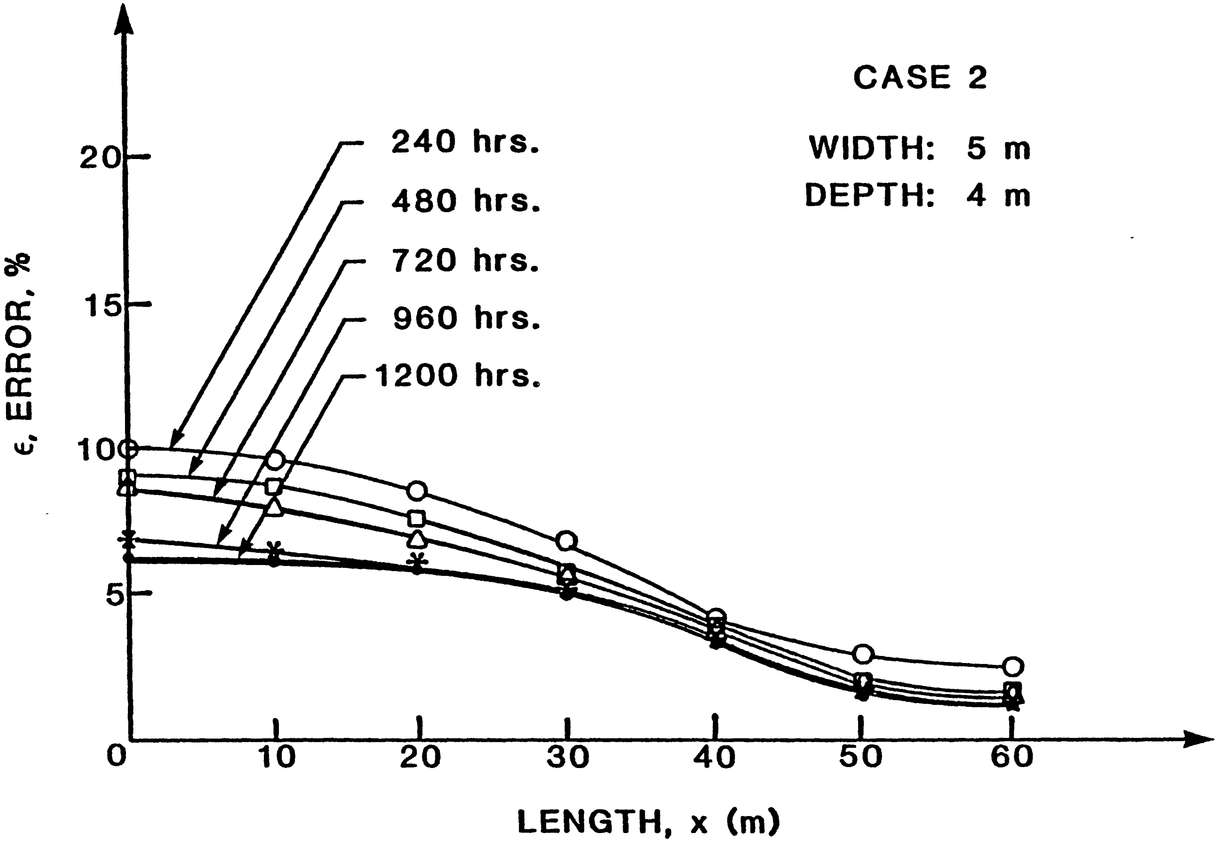


Figure 38. Error with Distance in x Direction for a Vertical Plane of 5 and 4 Meters in y and z Directions

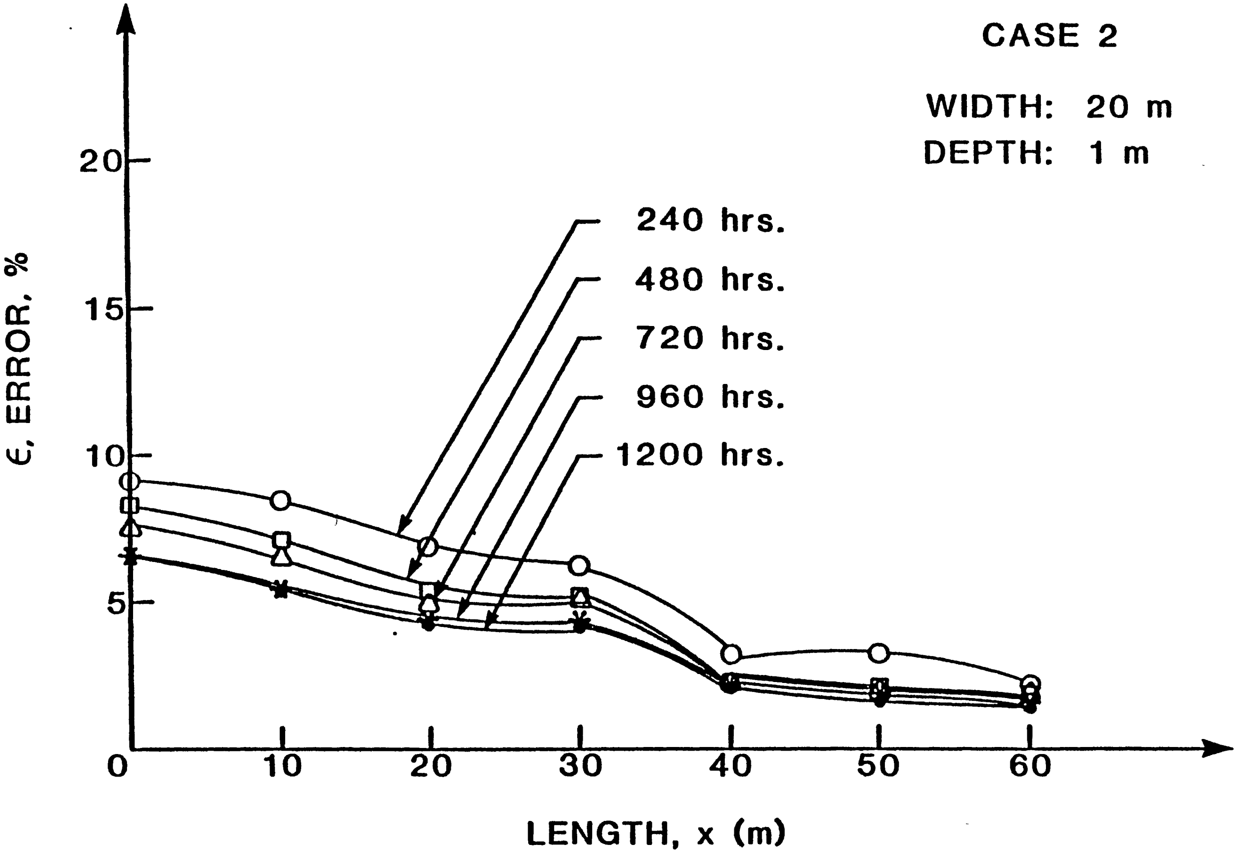


Figure 39. Error with Distance in x Direction for a Vertical Plane of 20 and 1 Meters in y and z Directions

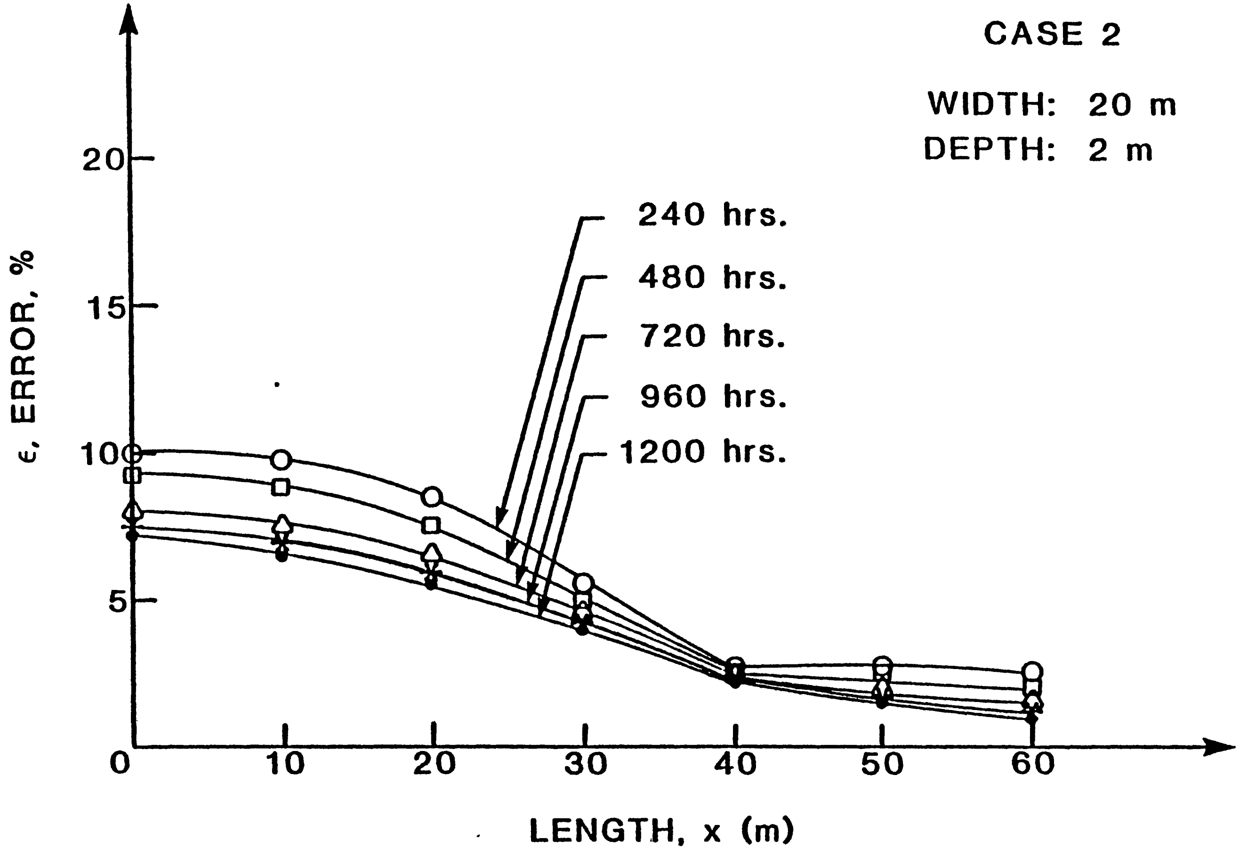


Figure 40. Error with Distance in x Direction for a Vertical Plane of 20 and 2 Meters in y and z Directions

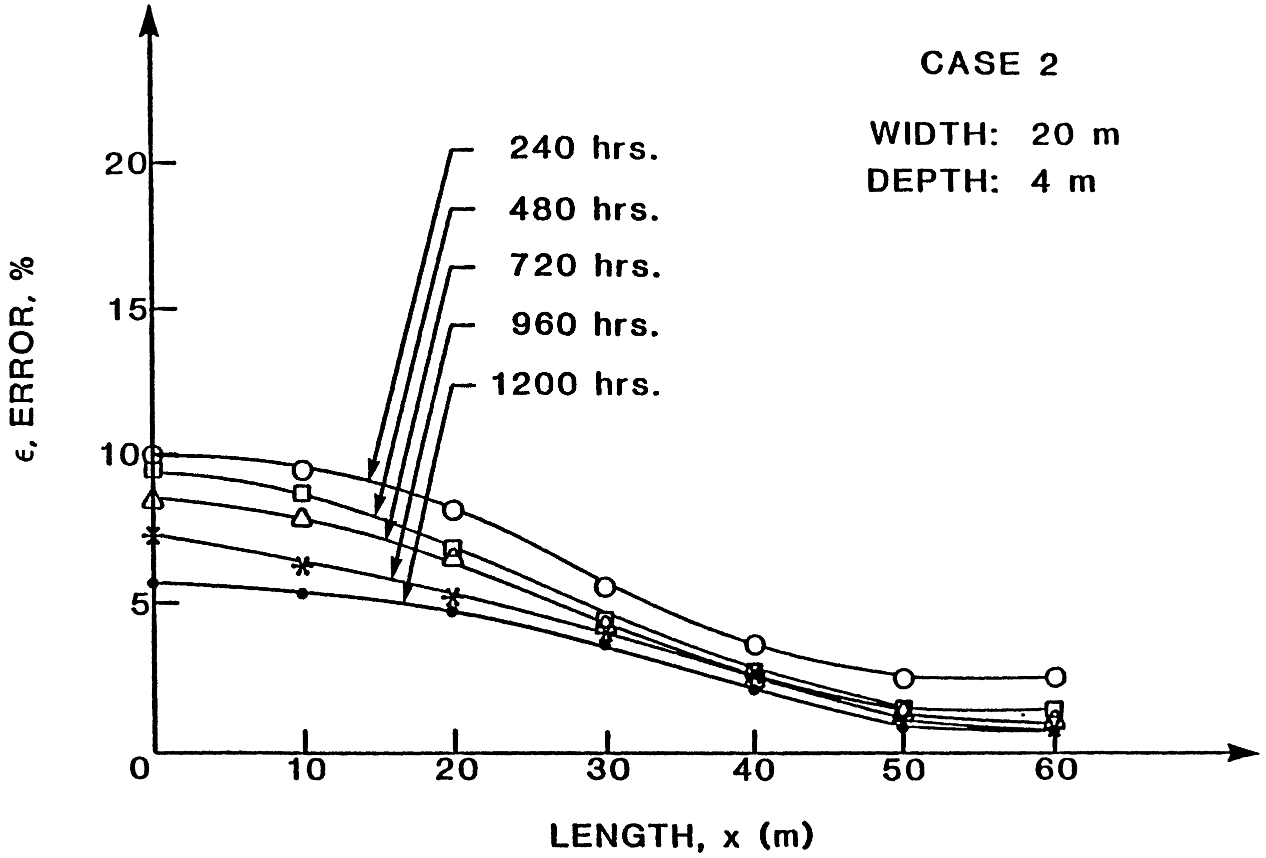


Figure 41. Error with Distance in x Direction for a Vertical Plane of 20 and 4 Meters in y and z Directions

according to y and z directions. The error, in percent, was derived from a comparison of the analytical solution with the developed model for the two cases. For Case 1, the maximum percentage of error is 12.50 and the minimum is 1.08. For Case 2, the percentage of error varied from 0.9 to 12.4. In both cases the error decreases as the distance from the point or line source increases; also, the error decreases with a longer time of application. The maximum percentage of errors is 12.5 and 12.4 for Case 1 and Case 2, respectively. This developed model, thus, gives close results with three-dimensional analytical solutions for a point source and a line source.

CHAPTER X

MODEL APPLICATION

Field Problem

This chapter describes the application of the model to a field problem. The Babylon landfill in Suffolk county, Long Island, New York. Kimmel and Braids (1974) provided the geographic map (Figure 42). The landfill for the city of Babylon is the main refuse disposal facility for a population of about 287,000. The landfill covers 35 acres, contains 1.7×10^8 ft^3 of refuse, and is 40 years old. The landfill has an incinerator and receives scavenger waste. There is leachate movement in the saturated groundwater zone. The spread of contamination in the aquifer is a major concern because this aquifer yields nearly all of the county's public water supply.

The landfill is on an outwash plain that is underlain mainly by coarse sand, a few streaks of gravel, and fine sand. This is known as the upper glacial aquifer on Long Island. At the Babylon landfill, the bottom of the upper glacial aquifer is 70 feet (21m) below the water table, the top is 18 feet (4.6m) below the land surface, and the aquifer is underlain by a single 10 feet (3.3m) thick layer of Gardiner's clay (Figure 43, Cleary et al., 1981). At the

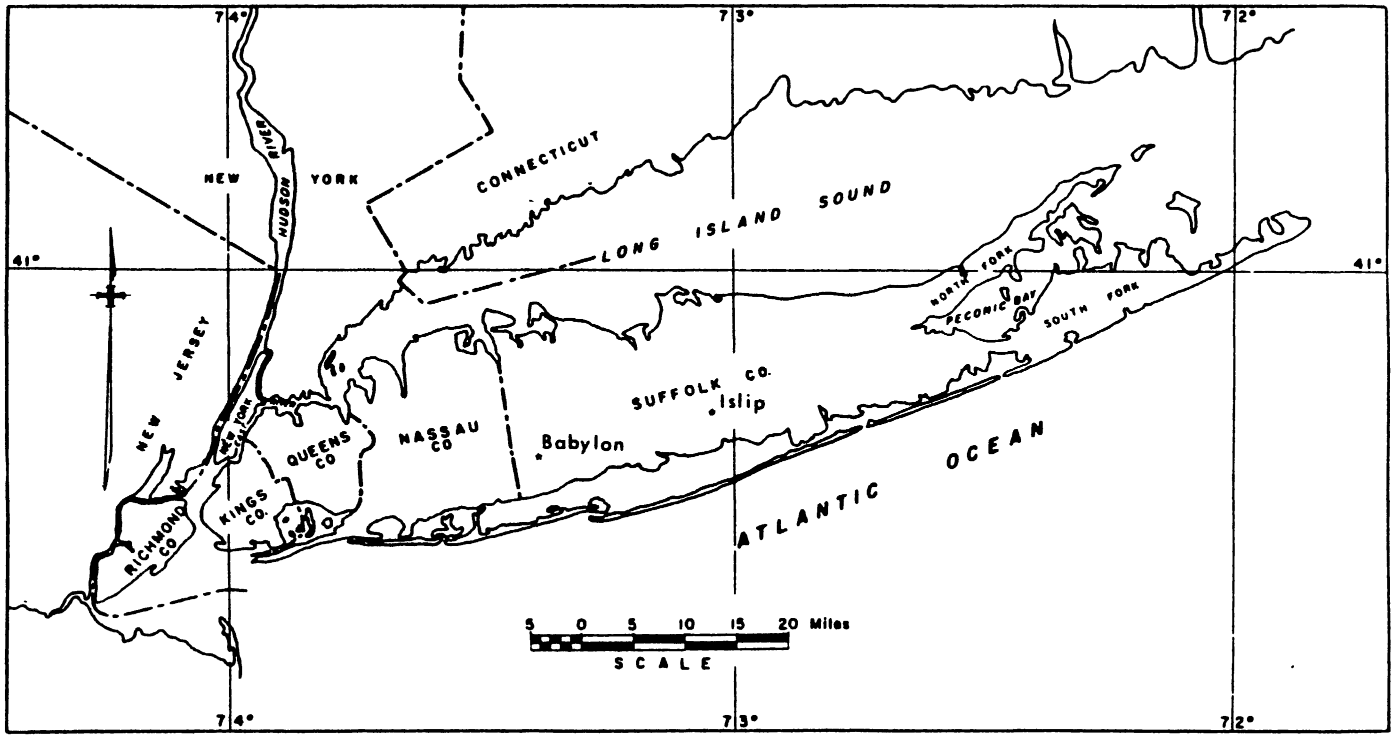


Figure 42. Location of Babylon in Suffolk County, New York

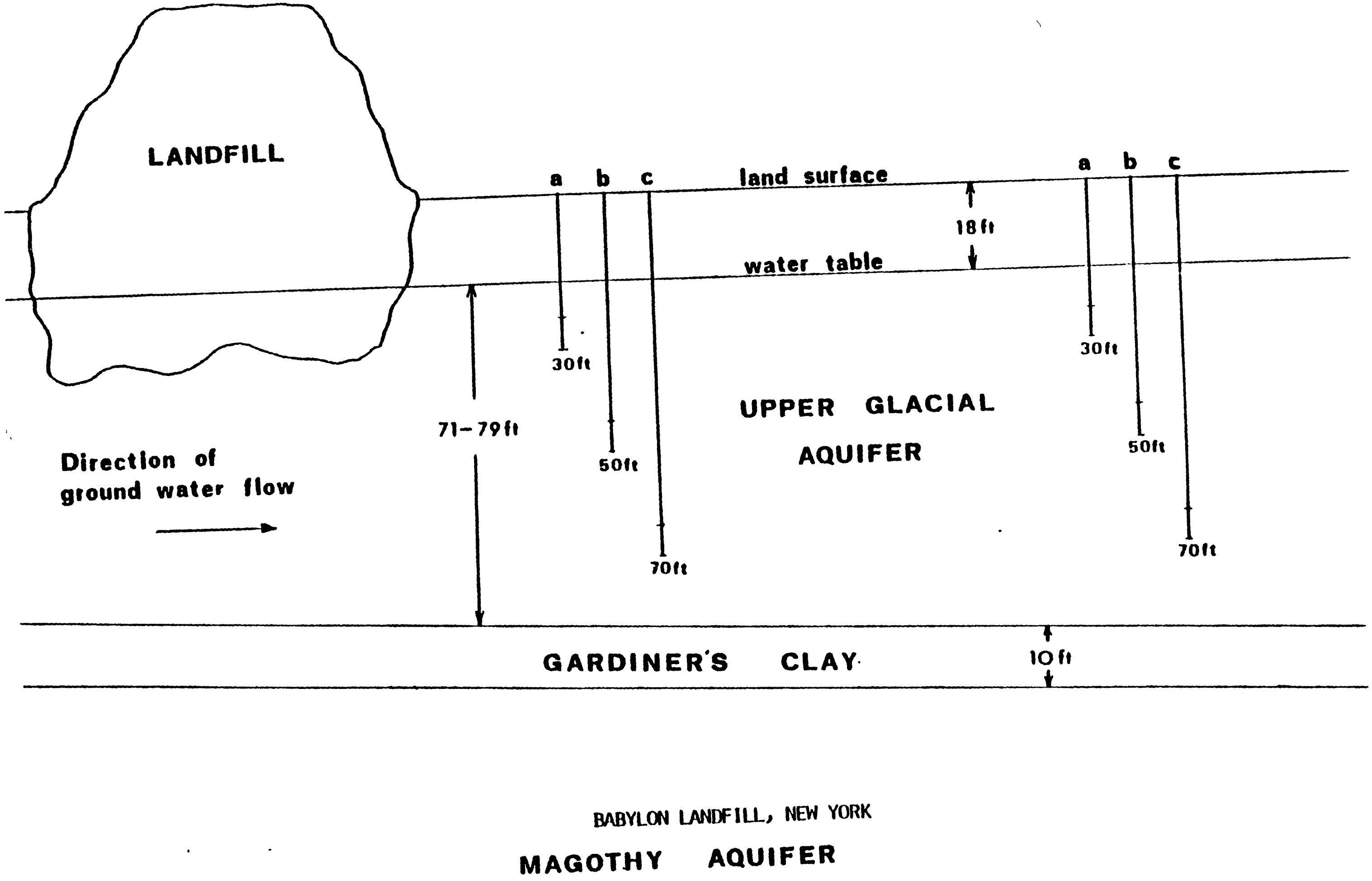


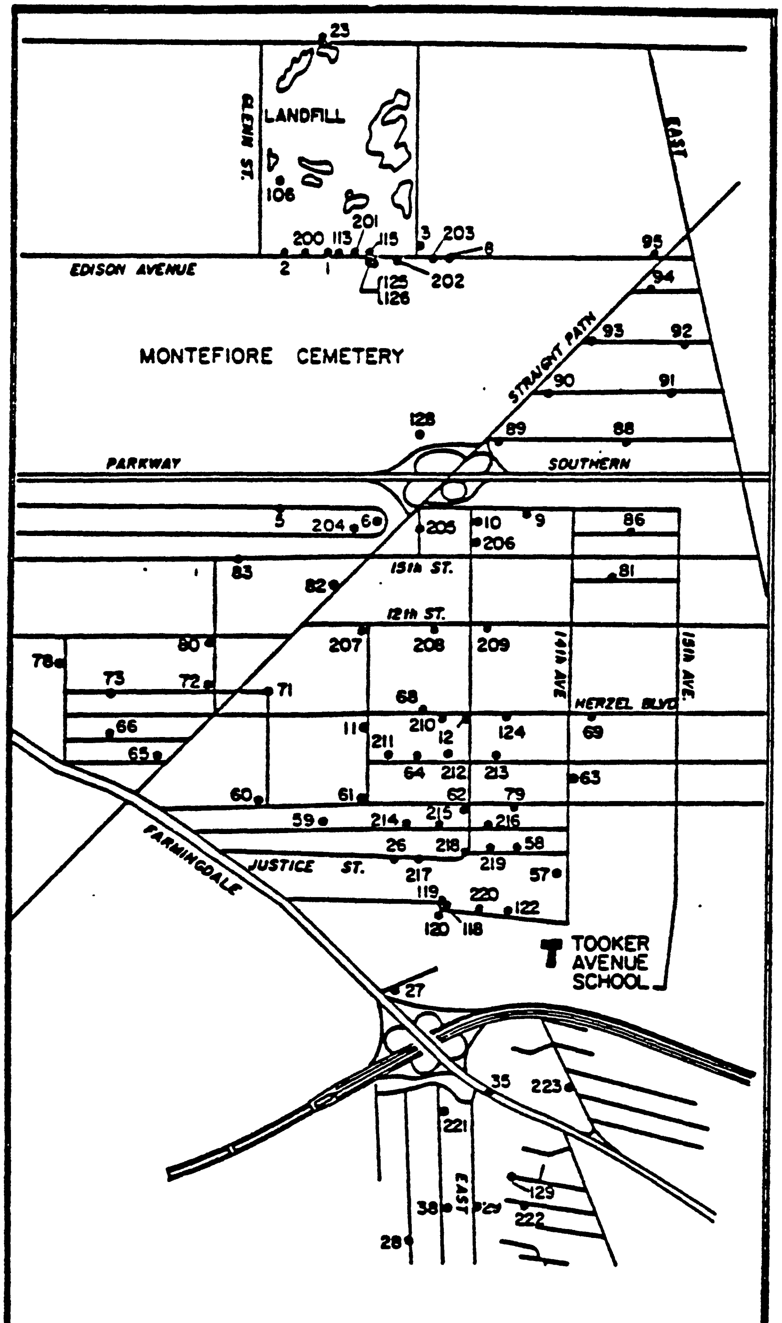
Figure 43. Simplified Cross Section at the Landfill Site Shown the Well Installation and Hydrological Setting

Babylon site, the regional flow in the upper glacial aquifer is primarily parallel to the water table, and along the hydraulic gradient of 0.002ft/ft (Kimmel and Braids, 1974) is uniform and fairly constant throughout the year. Water levels recorded for 18 months on a monthly basis at observation wells near the landfill have shown the water table fluctuation of the groundwater movement to be acceptable.

The parameter of Gureghian et al. (1981) will be used in this study and the model's result compared with theirs. The chloride ion (cl^-) is chosen as the dispersion tracer because it is free of chemical reactions such as ion exchange, sorption, and precipitation.

Prediction

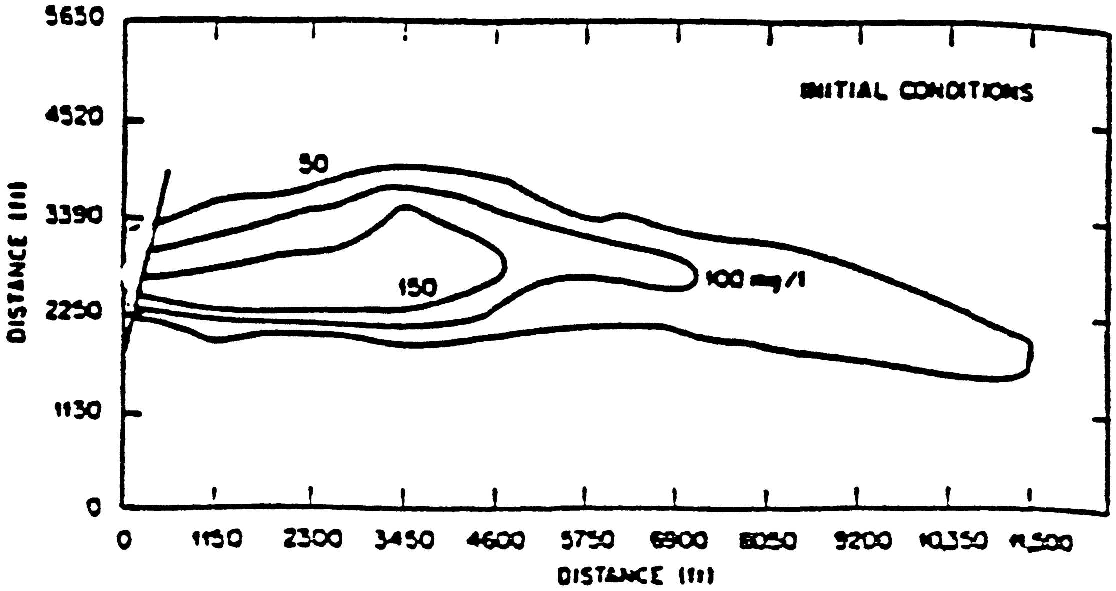
It was necessary to get the initial concentration at well numbers 1, 2, 8, 113, 125, 126, 200, 201, 202, and 203 (Figure 44), all located along Edison Avenue. These values were acquired from the November 1975 b-level well data (Figure 43). See Figure 45(a) for the first nine months of data for the initial nodal chloride ion concentration . Because we do not have exact information from these wells, we move the inclined line to the vertical line along the y-axis (Figure 45(b). Gureghian et al. calibrated the model parameter to match the June 1976 isolength. The final model parameters are 3.1ft/day in x direction and 0.2ft/day in y direction. Dispersivity is 140 feet and 250 feet in



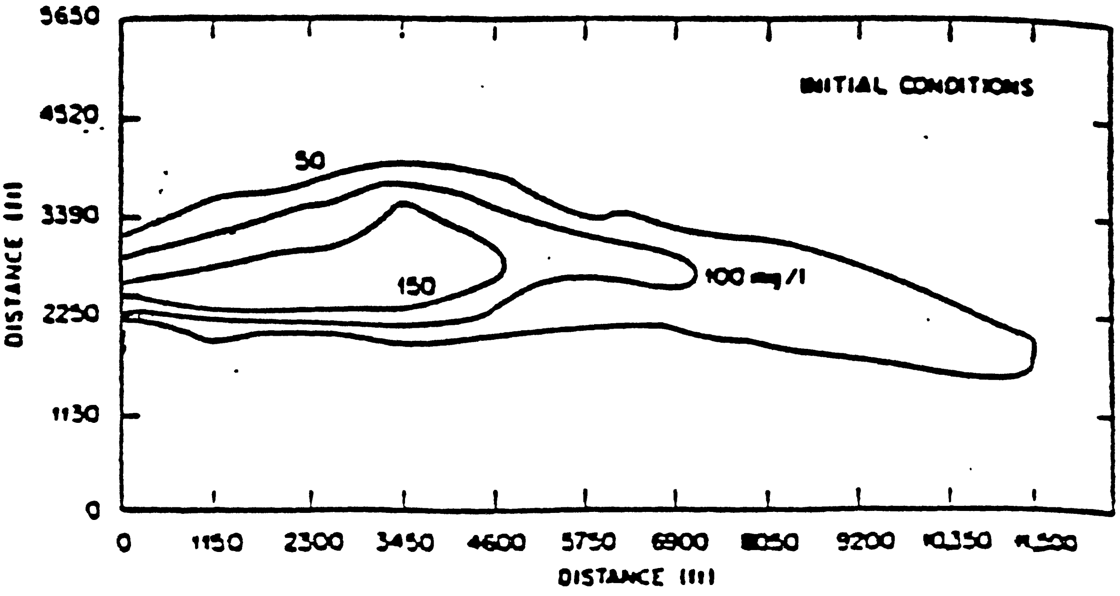
WATER QUALITY SAMPLING WELL LOCATIONS

Babylon Landfill

Figure 44. Water Quality Sampling Location



(a) Observed Initial Conditons



(b) Modified Initial conditions

Figure 45. Observed Initial and Modified Initial Conditions

longitudinal and transverse directions. The molecular diffusion coefficient is 1.0×10^{-7} ft^2/day. This is too small compared to the other dispersivity, so in this case we assume the molecular diffusion coefficient to be zero. For the time parameters, an initial time step is two days with a cyclic multiplying factor of 1.2 and a maximum time step of 15 days. Smaller initial and maximum time steps provide additional accuracy. Lengths of sides of elements range from 200 to 1500 feet (Figure 46).

Comparison

The model results were compared with the predicted values of Gureghian et al. (1981) and with actual observation values at June 1976 (216 days) and December 1976 (396 days). At time equal to 216 days, the model's value is close to the observation values because the parameters used in the model are the final parameters, not the calibration value. At time equal to 396 days, the model value was in agreement with the value predicted by Gureghian et al. (1981) and with the observation value.

Moving the initial condition does not seem to seriously influence the final result (Figures 47 and 48). The difference between the developed model and Gureghian's model may be due to small difference of the data. The error range between 0% and 14.7%. The model, however, is appliciable to the field problem.

longitudinal and transverse directions. The molecular diffusion coefficient is 1.0x10-7 ft2/day. This is too small compared to the other dispersivity, so we assume the molecular diffusion coefficient to be zero. For the time parameters, an initial time step is two days with a cyclic multiplying factor of 1.2 and a maximum time step of 15 days. Smaller initial and maximum time steps provide additional accuracy. Lengths of sides of elements range from 200 to 1500 feet (Figure 46).

Comparison

The model results were compared with the predicted values of Gureghian et al. (1981) and with actual observation values at June 1976 (216 days) and December 1976 (396 days). At time equal to 216 days, the model's value is close to the observation values because the parameters used in the model are the final parameters, not the calibration value. At time equal to 396 days, the model value was in agreement with the value predicted by Gureghian et al. (1981) and with the observation value.

Moving the initial condition does not seriously influence the final result (Figures 47 and 48). The difference between the developed model and Gureghian's model may be due to small differences of the data. The error in the developed model and observed data ranges between 0% and 14.7%. The error between the developed model and Gureghians's model ranges between 0% and 12.2%. The model, however, is appliciable to the field problem.

THICKNESS OF AQUIFER: H = 10 ft.
LENGTH OF AQUIFER: L = 12650 ft.
WIDTH OF AQUIFER: W = 5650 ft.
NUMBER OF NODES: 360
NUMBER OF ELEMENTS: 154

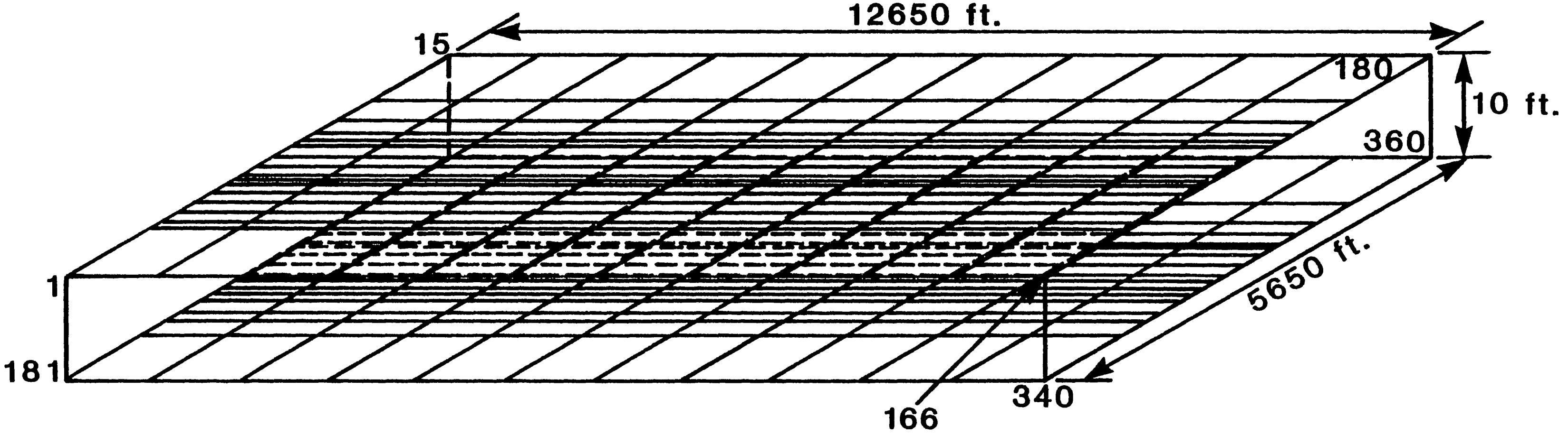


Figure 46. Three-Dimension Application to a Field Aquifer

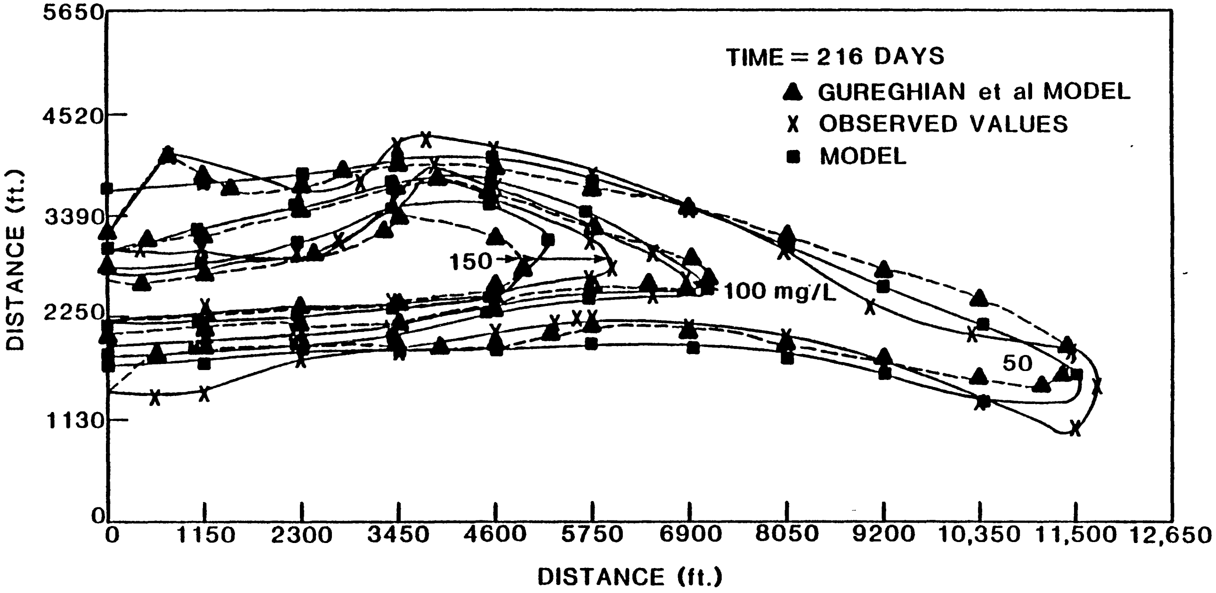


Figure 47. Chloride Concentrations Comparison at 216 Days

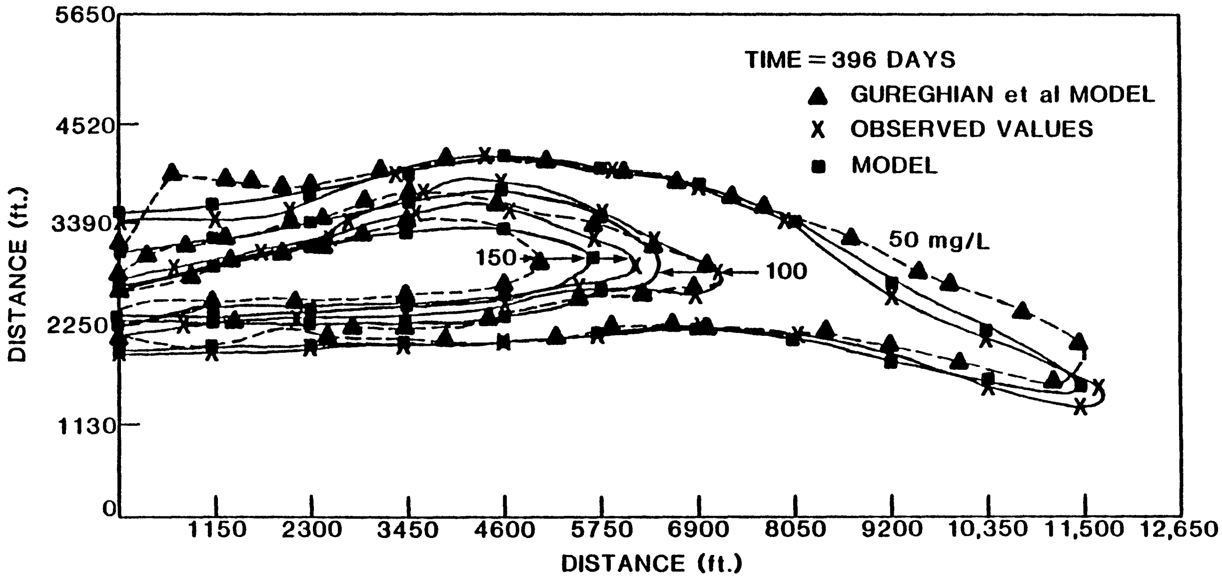


Figure 48. Chloride Concentrations Comparison at 396 Days

CHAPTER XI

CONCLUSIONS

The following conclusions can be drawn based on this study:

1. A three-dimensional transient model is developed using the Galerkin's finite element method to predict the migration of contaminants in saturated zones of aquifers.

2. The developed model has been validated against the existing analytical and numerical solutions in one, two and three dimensions.

3. Validation of the model for a one-dimensional case indicates that increasing the number of elements near a pollutant source improves the accuracy of the model. Away from the source, element size can be increased without sacrificing the accuracy.

4. The error analysis for the one-dimensional case indicates that the error varies from 0% to 13% using 20 to 100 elements in the problem.

5. The model is compared with a two-dimensional numerical model of Gureghian et al. (1980) and the analytical solution of Cleary and Ung (1978). The model results are in close agreement with the solutions of these two models for the same set of parameters.

6. The error analysis is presented for the two-dimensional case. The error varies between 0% to 38% and 0% to 57.5% for the two solutions for only one node. For other nodes, the error for the two solutions varies between 0 to 20% and 0 to 22%.

7. The Peclet number should be kept relatively low where the concentrations are relatively small, because the Peclet number is proportional to element size or length characteristics. The overshoot could be minimized by keeping the element size small in areas of low concentration.

8. The model is validated against two cases of three-dimensional analytical solutions, a point source and a line source (Yeh, 1981). Results of the model agree with those of the point and line source solutions.

9. The error analysis for the point source indicates that error between the developed model and the analytical solution varies from 1.08% to 12.50%. For the line source, the error ranges between 0.9% and 12.4%.

10. The developed model is applied to the Babylon landfill in Suffolk County, Long Island, New York. Chloride concentrations predicted by the model are in close agreement with the observed concentrations from a field of monitoring wells. The error ranges between 0% and 14.7%.

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APPENDIX A

LISTING OF COMPUTER PROGRAM

```
C
C
C     ***************************************************
C     *                                                 *
C     *    THIS PROGRAM SOLVES FOR THE CONCENTRATION    *
C     *                                                 *
C     *    DISTRIBUTION IN AN AQUIFER SYSTEM. THE PROGRAM *
C     *                                                 *
C     *    THIS PROGRAM SOLVES FOR THE CONCENTRATION    *
C     *                                                 *
C     *    DISTRIBUTION IN AN AQUIFER SYSTEM. THE PROGRAM *
C     *                                                 *
C     *    SOLVES A THREEE DIMENSIONAL GROUNDWATER      *
C     *                                                 *
C     *    DISPERSION EQUATION THAT DESCRIBES THE RESPONSE *
C     *                                                 *
C     *    OF AN AQUIFER DUE TO CONTAIMINATION. THE MODEL USE*
C     *                                                 *
C     *    GALERKIN PRINCIPLE OF THE FINITE ELEMENT METHOD *
C     *                                                 *
C     *                                                 *
C     *        THE PROGRAM WAS DEVELOPED AND WRITTEN    *
C     *                                                 *
C     *                      BY                         *
C     *                                                 *
C     *                YUAN PAO-CHIANG                  *
C     *                                                 *
C     *                                                 *
C     *             SCHOOL OF CIVIL ENGINEERING         *
C     *                                                 *
C     *              OKLAHOMA STATE UNIVERSITY          *
C     *                                                 *
C     *                    STILLWATER                   *
C     *                                                 *
C     *                     OKLAHOMA                    *
C     *                                                 *
C     *                       1986                      *
C     *                                                 *
C     ***************************************************
C     *                                                 *
C     *--------------SELECTED MODEL VARIABLES-----------------*
C     *                                                 *
C     * AA          TEMPORARY MATRIX IN SUBPROGRAM GAUSS     *
C     * ADJUST      SUBPROGRAM THAT DECOMPOSE SOLUTION MATRIX *
C     * AREA(I)     SURFACE AREA OF SIDE I OF ELEMENT        *
C     * BANDW       BANDWIDTH OF GLOBAL MATRIX               *
C     * BANDWI      SUBPROGRAM THAT CALCULATE BANDWIDTH      *
C     * BCD(I)      SPECIFIED CONDITION AT NODE I            *
C     * BOUND       SUBPROGRAM THAT HANDLES BOUNDARY CONDITION*
C     * C(I)        SOLUTION VECTOR FOR ROW I                *
C     * CINT(I)     INITIAL CONC AT NODE I                   *
C     * COEFF       COEFFICIENT OF REACTION CONSTANT & PORO. *
C     * COF(I)      COFACTOR I OF JACOBIAN MATRIX            *
C     * COLD(I)     PREVIOUS CONC AT NODE I                  *
C     * CONCS       CONCENTRATIONS                           *
C     * CPR(I)      SOURCE OR SINK'S CONC.                   *
C     * DELT        TIME INTERVAL                            *
C     * DIJ         ENTRIES OF THE JACOBIAN MATRIX           *
C     * DSFXN       DERIVATIVE OF SHAPE FUNCTION WITH RESPECT *
C     *             TO X AT NODAL POINT                      *
C     * DSFYN       DERIVATIVE OF SHAPE FUNCTION WITH RESPECT *
C     *             TO Y AT NODAL POINT                      *
C     * DSFZN       DERIVATIVE OF SHAPE FUNCTION WITH RESPECT *
C     *             TO Z AT NODAL POINT                      *
C     * DU          DETERMINANT OF JACOBIAN MATRIX           *
C     * DU          INVERSE OF DETERMINANT                   *
```

```
C     * ETA          LOCAL COORDINATE OF ELEMENT                  *
C     * FA           DNI/DX * DETERMINANT OF J                    *
C     * FACT         FACT =0 FOR STEADY STATE; 1 FOR TRANSIENT    *
C     * FB           DNI/DY * DETERMINANT OF J                    *
C     * FC           DNI/DZ * DETERMINANT OF J                    *
C     * GAUSS        SUBROUTINE THAT PERFORMS INTEGRATION         *
C     * GQPO         GAUSS INTEGRATION POINT                      *
C     * GQWT         GAUSS INTEGRATION WEIGHT                     *
C     * GLOBMX       GLOBAL STORATIVITY MATRIX                    *
C     * GLOBAL       SUBPROGRAM THAT ASSEMBLES GLOBAL MATRIX      *
C     * ID           IDENTIFICATION FOR CONSTANT CONC OR FLUX     *
C     *              ID=0 CONSTANT FLUX; 1 CONSTANT CONC.         *
C     * IN           CARD READER PARAMETER                        *
C     * IT           TOTAL NUMBER OF SIMULATION PERIOD            *
C     *              SOLUTION IS TO BE CARRIED OUT                *
C     * MATNO        MATERIAL NUMBER IF MORE THAN ONE             *
C     * MAX          TEMPORARY VARIABLE FOR BANDWIDTH             *
C     * MAXBD        BANDWIDTH OF GLOBAL MATRIX + 1               *
C     * NELMS        TOTAL NUMBER OF ELEMENTS                     *
C     * MNODE        MAXIMUM NUMBER OF NODES FOR EACH ELEMENT     *
C     * MK           TEMPORARY VARIABLE FOR BANDWIDTH             *
C     * MODEL        TYPE OF MODEL BEING DESIGNED, 1, 2, 3        *
C     * MXNOD        TOTAL NUMBER OF NODES IN THE SYSTEM          *
C     * NCONFN       = 1 FOR CONFINED; 0 OTHERWISE                *
C     * NCUBE        NUMBER OF NODES PER ELEMENT                  *
C     * ND           NODE FOR WHICH BOUNDARY CONDITION IS GIVEN*
C     * NOBC         NUMBER OF FIXED BOUNDARY CONDITIONS          *
C     * NE           ELEMENT NUMBER                               *
C     * NHE          NUMBER OF NODES FOR HEAD ESTIMATION          *
C     * NN           NUMBER OF NODES IN A GIVEN ELEMENT           *
C     * NODE         NODE NUMBERS FOR AN ELEMENT                  *
C     * NORDER       ORDER OF GAUSS INTEGRATION                   *
C     * NUMAT        TOTAL NUMBER OF MATERIALS IF MORE THAN ONE*
C     * NPPED        NUMBER OF PUMPING PERIODS                    *
C     * NPT          TOTAL NUMBER OF POTINTS                      *
C     * NQW          NUMBER OF SOURCE OR SINK PER ELEMENT         *
C     * NSTEDY       OPTION FOR STEADY STATE OR TRANSIENT CASE    *
C     * NWELS         NUMBER OF PUMPING WELLS                     *
C     *              NSTEDY=1 FOR TRANSIENT,0 FOR STEADY STATE    *
C     * PHY          LOCAL COORDINATE OF ELEMENT                  *
C     * PORS         VALUE OF POROSITY                            *
C     * PT           PRINT PARAMETER                              *
C     * QW           SOURCE OR SINK(-VE FOR SINK,+VE SOURCE       *
C     * R(I,J)       ELEMENT STORATIVITY MATRIX                   *
C     * RECT         INTERMEDIATE RIGHTHAND SIDE VECTOR           *
C     * S            STORAGE COEFFIENT/STORATIVITY OF AQUIFER     *
C     * SIJ          SUMMATION OF DERIV. OF SHAPE FUNCTIONS       *
C     *              WITH RESPECT TO X COORDINATE                 *
C     * SIKJO        SUMMATION OF NI*NJ                           *
C     * SILJC        SUMMATION OF NI AT NODE I                    *
C     * SISJ         SNJ * SNIDU                                  *
C     * SKJ          SUMMATION OF DERIV. OF SHAPE FUNCTION        *
C     *              WITH RESPECT TO Y COORDINATE                 *
C     * SLJ          SUMMATION OF DERIV. OF SHAPE FUNCTION        *
C     *              WITH RESPECT TO Z COORDINATE                 *
C     * SNIDU        SNI * DU *                                   *
C     * SOLVLU       SUBROUTINE THAT SOLVES SYSTEM'S EQUATIONS    *
C     * SR           REACTION CONSTANT                            *
C     * SS(I)        TEMPORARY ARRAY FOR GAUSS POINTS             *
C     * STOMX        GLOBAL CONDUCTIVITY MATRIX                   *
C     * SUM          TEMPORARY VARIABLE FOR RHS VECTOR            *
C     * TOL          TOLERANCE LIMIT FOR COMPUTATION              *
C     * TOTAL        ELAPSED TIME (IN USER'S CHOICE OF UNITS)     *
C     * VLX          VELOCITY RESPECT TO X DIRECTION              *
C     * VLY          VELOCITY RESPECT TO Y DIRECTION              *
C     * VLZ          VELOCITY RESPECT TO Z DIRECTION              *
```

```
C    * VOLUME       VOLUME OF ELEMENT                              *
C    * WK(I,J)       ELEMENT CONDUCTIVITY MATIX                    *
C    * WTAV         AVERAGE WEIGHT FOR GAUSS INTEGRATION           *
C    * X            X COORDINATE IN GLOBAL SYSTEM                  *
C    * Y            Y COORDINATE IN GLOBAL SYSTEM                  *
C    * Z            Z COORDINATE IN GLOBAL SYSTEM                  *
C    * ZETA         LOCAL COORDINATE OF ELEMENT                    *
C    * +++++++++++++++++++++++++++++++++++++++++I++++++++++++
C
C      MAIN PROGRAM
C      PURPOSES:
C      THE MAIN PROGRAM PRINTS THE TITLE OF THE PROBLEM, DIEMNSION
C      THE SIZE OF PROBLEM, CONTROL SEQUENCE OF COMPUTATIONS
C      AND FINALLY PRINTS THE CONCENTRATION RESULTS FROM
C      THE SUBROUTINE SOLVER
C      ------------------------------------------------------------
C
       IMPLICIT REAL*8 (A-H,O-Z)
       COMMON /SUBA/SIJ(400),SKJ(400),SLJ(400),SMJ(400),SWJ(400),
      1SOJ(400),SIKJO(200),SILJC(200),DNIDX(2000),DNIDY(2000),
      2DNIDZ(2000),WKX(400),WKY(400),WKZ(400),DXX(400),DYY(400),
      3DZZ(400),VLX(400),VLY(400),VLZ(400),XQ(8),YQ(8),ZQ(8),AA(3)
       COMMON /SUBB/AA1(8),AA2(8),AA3(8),DSFXN(64),DSFYN(64),
      1DSFZN(64),DSFX(64),DSFY(64),DSFZ(64),ETA(36),PHY(36),
      2ZETA(64),SA(6),SFV(8),FX(8),FY(8),FZ(8),F(24),G(24),H(24),
      3GQPO(5),GQWT(5),SS(6),DD(6),NODD(8),MATNO(8),MNO(8)
       COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
       COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
       COMMON /SUBE/TKX(400),TKY(400),TKZ(400),X(400),Y(400),Z(400)
       COMMON /SUBF/C(400),CINT(400),COLD(400),QW(400),BCD(8)
       COMMON /SUBG/ID(400),ND(400)
       COMMON /SUBH/NODE(400,400)
C      ------------------------------------------------------------
       DATA IN,LP/10,6/
C
       WRITE(PT,5)
    5  FORMAT(1H1)
       WRITE(PT,10)
   10  FORMAT(///////,44X,'INPUT DATA FOR THREE-DIMENSIONAL'/44X,
      1'--------------------------------'/40X,
      2'GROUNDWATER DISP BY FINITE ELEMENT METHOD'/40X,
      3'-----------------------------------------')
C       DIMENSION THE SIZE OF PROBLEM
       READ(IN,15)NELMS,MXNOD,MNOPE,NSTEDY,NDBC,DELT
   15  FORMAT(5I4,F10.5)
       DO 25 J=1,NELMS
       READ(IN,20) (VLX(I),VLY(I),VLZ(I),I=1,MXNOD)
       READ(IN,20) (DXX(I),DYY(I),DZZ(I),I=1,MXNOD)
   20  FORMAT(8D11.3)
   25  CONTINUE
       CALL INPUT(NWELS,NPERS,NOMAT,NCE,IT,FACT,NELMS,MXNOD,
      1MNOPE,NE,DELT,NSTEDY,LP,IN,NDBC)
C
       CALL SHAPE(NELMS,MXNOD,MODEL,NX,NN,INDEX,MNOPE)
C
       CALL BOUND(MXNOD,DELT,NDBC,NSTEDY)
       CALL WIDTH(BANDW,IROW,MXNOD)
       WRITE(PT,35)BANDW,IROW
   30  FORMAT(/,5(5X,I4,4X,D11.3))
   35  FORMAT(//36X,'MAXIMUM BANDWIDTH = ',I3,' ON ROW NO.',I3)
C
       CALL ADJUST(MXNOD,BANDW)
       WRITE(PT,40)
   40  FORMAT(1H1)
       WRITE(PT,45)
   45  FORMAT(///////,44X,'OUTPUT FOR THREE-DIMENSIONAL'/44X,
```

```
     1'-------------------------------'/38X,
     2'GROUNDWATER DISP BY FINITE ELEMENTS METHOD'/38X,
     3'-----------------------------------------')
      TIME=0.0
      WRITE(PT,50)TIME
   50 FORMAT(/40X,'INITIAL CONC DISTRIBUTION AT TIME =',F8.3)
      WRITE(PT,55)
   55 FORMAT(/,5(5X,'NODES',5X,'CONCS'))
      WRITE(PT,30)(I,CINT(I),I=1,MXNOD)
      CHK = 0
      DO 95 LT = 1,IT
      TIME = TIME+DELT
      CHK = CHK+1
C
      CALL RIGHTV(MXNOD,BANDW)
C
      CALL SOLVER(MXNOD,BANDW,NDBC)
      IF(CHK.LT.6)GO TO 75
      WRITE(PT,60)
   60 FORMAT(1H1)
      WRITE(PT,65)TIME
   65 FORMAT(/////,44X,'CONC DISTRIBUTIONS AT TIME = ',F8.3,' DAYS')
      DO 70 I = 1,MXNOD
   70 C(I) =C(I)
      WRITE(PT,55)
      WRITE(PT,30)(I,C(I),I=1,MXNOD)
      CHK = 0
   75 DO 80 I = 1,MXNOD
   80 COLD(I) =C(I)
      WRITE(PT,85)
   85 FORMAT(1H1)
      WRITE(PT,30)(I,COLD(I),I=1,MXNOD)
      IF(CHK.LT.5)GO TO 90
   90 CONTINUE
      WRITE(PT,95)
   95 FORMAT(1H1)
      STOP
      END
C     ****************************************************************
C
      SUBROUTINE INPUT(NWELS,NPERS,NOMAT,NCE,IT,FACT,NELMS,MXNOD,
     1MNOPE,NE,DELT,NSTEDY,LP,IN,NDBC)
C
C     PURPOSE:THIS SUBROUTINE INPUT AND PRINT ALL THE DATA USED IN
C             THIS PROGRAM
C     ****************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBE/TKX(400),TKY(400),TKZ(400),X(400),Y(400),Z(400)
      COMMON /SUBF/C(400),CINI(400),COLD(400),QW(400),BCD(8)
      COMMON /SUBG/ID(400),ND(400)
      COMMON /SUBH/NODE(400,400)
C
      READ(IN,20)NWELS,NPERS,NOMAT,NCE,IT,FACT,FACT3
   20 FORMAT(5I4,F10.5,F10.6)
      WRITE(PT,30)NELMS,MXNOD,MNOPE,NOMAT,NWELS,NCE
   30 FORMAT(//25X,'TOTAL NO. OF ELEMENTS               =',I4/25X,
     1'TOTAL NO. OF NODES               =',I4,/25X,
     2'MAXIMUM NO  OF NODES PER ELEMENT =',I4/25X,
     3'TOTAL NO. OF MATERIALS           =',I4/25X,
     4'NUMBER OF PUMPING WELLS          =',I4/25X,
     5'NUMBER OF CONCS TO BE ESTIMATED  =',I4///)
      WRITE(PT,35)NPERS,IT,FACT
   35 FORMAT(////25X,'NUMBER OF PUMPING PERIODS          =',I4/25X,
     1'TOTAL SIMULATION PERIODS         =',I4/25X,
     2'FACTOR MULTIPLYING COMPUTED CONCS =',F10.5///)
      WRITE(PT,40)DELT,NSTEDY,NDBC
```

```
 40   FORMAT(/////25X,'STEP SIZE                              =',F10.5/25X,
     1'STATE OF PROBLEM                   =',I4/25X,
     2'NO. OF SPECIFIED CONDITIONS        =',I4)
      WRITE(PT,45)
 45   FORMAT(1H1,////////,39X,'COORDINATES AND INITIAL CONCS OF NODES (L
     1)')
      WRITE(PT,50)
 50   FORMAT(//25X,'NODES        Y(I)             X(I)             Z(I)
     1  CINT(I)'/)
      DO 65 I = 1,MXNOD
      READ(IN,55)Y(I),X(I),Z(I),QW(I),CINT(I)
 55   FORMAT(5D10.2)
      WRITE(PT,60)I,X(I),Y(I),Z(I),CINT(I)
 60   FORMAT(25X,I4,4(4X,D10.2))
 65   CONTINUE
      DO 70 J = 1,MXNOD
      QW(J) = QW(J)*FACT3
 70   CONTINUE
      WRITE(PT,75)
 75   FORMAT(1H1,////////56X,'NODE-ELEMENT RELATIONSHIP')
      WRITE(PT,80)
 80   FORMAT(//25X,'ELEMS          N1          N2          N3          N4
     1 N5          N6          N7          N8'//)
      DO 100 JK = 1,NELMS
      READ(IN,90)NE,(NODE(JK,I),I=1,MNOPE)
      WRITE(PT,95)NE,(NODE(JK,I),I=1,MNOPE)
 90   FORMAT(9I4)
 95   FORMAT(26X,I4,8(6X,I4))
100   CONTINUE
      WRITE(PT,105)
105   FORMAT(1H1,////////44X,'FIXED BOUNDARY CONDITIONS'///5X,
     15('NODE          ID',9X))
      READ(IN,110)(ND(JK),JK=1,NDBC)
110   FORMAT(8I4)
      READ(IN,125)(ID(ND(JK)),JK=1,NDBC)
115   FORMAT(6I2)
      WRITE(PT,130)(ND(JK),ID(ND(JK)),JK=1,NDBC)
125   FORMAT(//,5(5X,I4,7X,I2,4X))
      RETURN
      END
C     ************************************************************
C
      SUBROUTINE SHAPE(NELMS,MXNOD,MODEL,NX,NN,INDEX,MNOPE)
C
C     PURPSE: THIS SUBROUTINE DOES THE INTERGRATION OF THE BASIS
C     FUNCTION FOR ALL ELEMENTS USING GAUSSIAN QUADRATURE
C     ************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBA/SIJ(400),SKJ(400),SLJ(400),SMJ(400),SWJ(400),
     1SOJ(400),SIKJO(200),SILJC(200),DNIDX(2000),DNIDY(2000),
     2DNIDZ(2000),WKX(400),WKY(400),WKZ(400),DXX(400),DYY(400),
     3DZZ(400),VLX(400),VLY(400),VLZ(400),XQ(8),YQ(8),ZQ(8),AA(3)
      COMMON /SUBB/AA1(8),AA2(8),AA3(8),DSFXN(64),DSFYN(64),
     1DSFZN(64),DSFX(64),DSFY(64),DSFZ(64),ETA(36),PHY(36),
     2ZETA(64),SA(6),SFV(8),FX(8),FY(8),FZ(8),F(24),G(24),H(24),
     3GQPO(5),GQWI(5),SS(6),DD(6),NODD(8),MATNO(8),MNO(8)
      COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      COMMON /SUBE/TKX(400),TKY(400),TKZ(400),X(400),Y(400),Z(400)
      COMMON /SUBF/C(400),CINT(400),COLD(400),QW(400),BCD(8)
      COMMON /SUBH/NODE(400,400)
C
C     INFORMATION OF LOCAL COORDINATE FOR EACH ELEMENT
C
      DATA (ETA(I),I=1,36)/
     1-1.D0, 1.D0, 1.D0, -1.D0, -1.D0, 1.D0, 1.D0, -1.D0,
```

```
     20.DO,0.DO,0.DO,0.DO,
     3-1.DO, 1.DO, -1.DO, 1.DO, -1.DO, 1.DO, 1.DO, -1.DO,
     4-1.DO, -1.DO, 1.DO, 1.DO, -1.DO, -1.DO, 1.DO, 1.DO,
     5-1.DO, -1.DO, 1.DO, 1.DO, 1.DO, 1 DO, -1.DO, -1.DO/
C     --------------------------------------------------------------
      DATA (ZETA(I),I=1,36)/
C
     1-1.DO,-1.DO,1.DO,1.DO,-1.DO,-1.DO,1.DO,1.DO,-1.DO,1.DO,-1.DO,1 DO,
     20.DO,0.DO,0.DO,0.DO,
     3-1.DO,-1.DO,1.DO,1.DO,-1.DO,-1.DO,1.DO,1.DO,
     4-1 DO,-1.DO,1.DO,1.DO,-1 DO,-1.DO,-1.DO,-1.DO,1.DO,1.DO,1.DO,1.DO/
C     --------------------------------------------------------------
      DATA (PHY(I),I=1,36)/
C
     11.DO,1.DO,1.DO,1.DO,-1.DO,-1.DO,-1.DO,-1 DO,1.DO,1.DO,-1.DO,-1.DO,
     21.DO,1.DO,-1.DO,-1.DO,0.DO,0.DO,0.DO,0.DO,
     31.DO,1.DO,1.DO,1.DO,
     4-1.DO,-1.DO,-1.DO,-1.DO,1.DO,1.DO,1.DO,1.DO,
     5-1.DO,-1.DO,-1.DO,-1.DO/
C     --------------------------------------------------------------
      DATA IN,LP/10,6/
      INDEX=0
C
C     INITIALIZING THE GLOBAL MATRICES AND VECTOR
C
      DO 10 I = 1,MXNOD
      DO 10 J = 1,MXNOD
      GLOBMX(I,J)=0.0
      STOMX(I,J)=0.0
   10 RMX(I) = 0 0
C
C     START THE INTEGRATION ELEMENT BY ELEMENT
C
      DO 80 IL = 1,NELMS
   15 MODEL = 3
      NN = MNOPE
      XX = 0.0
      YY=0.0
      ZZ=0.0
      NORDER=2
C
C     GAUSS INTEGRATION POINTS AND WEIGHTS
C
      IF(NORDER-2)16,16,17
   16 GQPO(1) = -0.577350269189626DO
      GQPO(2) =  0.577350269189626DO
      GQWT(1) =  1.000000000000000DO
      GQWT(2) =  1 000000000000000DO
      GO TO 19
   17 IF(NORDER.GT.3)GO TO 18
      GQPO(1) = -0.774596669241483DO
      GQPO(2) =  0.000000000000000DO
      GQPO(3) =  0.774596669241483DO
      GQWT(1) =  0.555555555555556DO
      GQWT(2) =  0.888888888888889DO
      GQWT(3) =  0.555555555555556DO
      GO TO 19
   18 GQPO(1) = -0 861136311594053DO
      GQPO(2) = -0.339981043584856DO
      GQPO(3) =  0.339981043584836DO
      GQPO(4) =  0.861136311594053DO
      GQWT(1) =  0.347854845137454DO
      GQWT(2) =  0.652145154862546DO
      GQWT(3) =  0.652145154862546DO
      GQWT(4) =  0.347854845137454DO
C
```

```
      D11=0.
      D12=0.
      D13=0.
      D21=0.
      D22=0.
      D23=0.
      D31=0.
      D32=0.
      D33=0.
      SS(1) = ET
      SS(2) = ZT
      SS(3) = YP
      DO 67 I = 1,NN
      IF(NODE(IL,I).EQ.0)GO TO 67
   40 DD(1) =ETA(I)
      DD(2) =ZETA(I)
      DD(3) =PHY(I)
      DO 41 KP=1,MODEL
   41 AA(KP)=1.D0+DD(KP)*SS(KP)
C     IF(I.GT.8)GO TO 60
      ALP=0.125D0*(4-MODEL)
      ALPHA=ALP*AA(1)*AA(2)*AA(3)
      SFV(I)=ALPHA
      DNET=ALP*DD(1)*AA(2)*AA(3)
      DNZT=ALP*DD(2)*AA(1)*AA(3)
      DNPH=ALP*DD(3)*AA(1)*AA(2)
      GO TO 66
C
   66 AA1(I)=DNET
      AA2(I)=DNZT
      AA3(I)=DNPH
      YQQ  =YQ(I)
      XQQ  =XQ(I)
      ZQQ  =ZQ(I)
C
C     GENERATING THE JACOBIAN MATRIX
C     D11  =DX/DET    D12  =DY/DET    D13  =DZ/DET
C     D21  =DX/DZT    D22  =DY/DZT    D23  =DZ/DZT
C     D31  =DX/DYP    D32  =DY/DYP    D33  =DZ/DYP
C
      D11  =DNET*XQQ+D11
      D12  =DNET*YQQ+D12
      D13  =DNET*ZQQ+D13
      D21  =DNZT*XQQ+D21
      D22  =DNZT*YQQ+D22
      D23  =DNZT*ZQQ+D23
      D31  =DNPH*XQQ+D31
      D32  =DNPH*YQQ+D32
      D33  =DNPH*ZQQ+D33
   67 CONTINUE
      INDEX=IL
C
C     COMPUTING THE DETERMINANT DU OF THE JACOBIAN MATRIX
C
      DU=D11*D22*D33+D12*D23*D31+D13*D21*D32
     1-D13*D22*D31-D21*D12*D33-D11*D32*D23
      IF(DU.EQ.0.0)GO TO 68
      DU=1./DU
      GO TO 69
   68 IF(INDEX.NE.1)GO TO 75
      WRITE(PT,79)NE,ET,ZT,YP,(NODE(IL,I),XQ(I),
     1YQ(I),ZQ(I),I=1,NN)
      GO TO 75
C
C     ESTIMATING THE DERIVATIVES OF THE SHAPE FUNCTION'NI'
C     WITH RESPECT TO THE X,Y,Z COORDINATES.
```

```
C      F(I) = DNI/DX  FY(I) = DNI/DY  FZ(I) = DNI/DZ
C
C      COMPUTING THE COFACTOR OF THE JACOBIAN MATRIX
C
   69  COF1=(D22*D33-D23*D32)
       COF2=-(D21*D33-D23*D31)
       COF3=(D21*D32-D22*D31)
       COF4=-(D12*D33-D13*D32)
       COF5=(D11*D33-D13*D31)
       COF6=-(D11*D32-D12*D31)
       COF7=(D12*D23-D13*D22)
       COF8=-(D11*D23-D13*D21)
       COF9=(D11*D22-D12*D21)
C
       DO 70 I = 1,NN
       IF(NODE(IL,I).EQ.0)GO TO 70
       F(I)  =DU*(AA1(I)*COF1+AA2(I)*COF4+AA3(I)*COF7)
       FY(I) =DU*(AA1(I)*COF2+AA2(I)*COF5+AA3(I)*COF8)
       FZ(I) =DU*(AA1(I)*COF3+AA2(I)*COF6+AA3(I)*COF9)
   70  CONTINUE
C
       XJCOB = 1./DU
       DU = XJCOB*W
       II=0
C
   71  DO 74 I = 1,NN
       IF(NODE(IL,I).EQ.0)GO TO 74
       II=II+1
       FA=F(I)*DU
       FB=FY(I)*DU
       FC=FZ(I)*DU
       SNI=SFV(I)
       SNIDU=SNI*DU
       SNI=SNI*W
       J2=0
C
       DO 73 J = 1,NN
       IF(NODE(IL,J).EQ.0)GO TO 73
       J2=J2+1
       FK=F(J)
       FYK=FY(J)
       FZK=FZ(J)
       SNJ=SFV(J)
       XIXJ=SNJ*SNIDU
       IIJJ=(II-1)*NCUBE+J2
       SIKJO(IIJJ)=SIKJO(IIJJ)+XIXJ
       SIJ(IIJJ)=SIJ(IIJJ)+FA*FK
       SKJ(IIJJ)=SKJ(IIJJ)+FB*FYK
       SLJ(IIJJ)=SLJ(IIJJ)+FC*FZK
       WKX(IIJJ)=WKX(IIJJ)+SNIDU*FK
       WKY(IIJJ)=WKY(IIJJ)+SNIDU*FYK
       WKZ(IIJJ)=WKZ(IIJJ)+SNIDU*FZK
       KK=0
C
       DO 72 LO = 1,NN
       IF(NODE(IL,LO).EQ.0)GO TO 72
       KK=KK+1
       KIJ=(IIJJ-1)*NCUBE+KK
       DNIDX(KIJ)=DNIDX(KIJ)+XIXJ*F(LO)
       DNIDY(KIJ)=DNIDY(KIJ)+XIXJ*FY(LO)
       DNIDZ(KIJ)=DNIDZ(KIJ)+XIXJ*FZ(LO)
   72  CONTINUE
   73  CONTINUE
C
       SILJC(II)=SILJC(II)+SNIDU
       IF(KX.NE.1)GO TO 74
```

```
C
  19   KK = 0
       DO 20 J =  1,NN
       MATNO(J)=1
       K = NODE(IL,J)
       IF(K.EQ.0)GO TO 20
       KK=KK+1
       XQ(J)=X(K)
       YQ(J)=Y(K)
       ZQ(J)=Z(K)
       NODD(KK)=K
       MNO(KK)= MATNO(J)
  20   CONTINUE
       NCUBE=KK
C
C      CHECKING AREA AND VOLUME OF EACH ELEMENT
C
       AREA(1)= (XQ(2)-XQ(1))*(YQ(4)-YQ(1))
       AREA(2)= (XQ(2)-XQ(1))*(ZQ(2)-ZQ(6))
       AREA(3)= (YQ(7)-YQ(6))*(ZQ(2)-ZQ(6))
       AREA(4)= (YQ(8)-YQ(5))*(XQ(6)-XQ(5))
       AREA(5)= (ZQ(4)-ZQ(8))*(XQ(7)-XQ(8))
       AREA(6)= (ZQ(1)-ZQ(5))*(YQ(8)-YQ(5))
       AREA1=AREA(1)+AREA(2)+AREA(3)
       AREA2=AREA(4)+AREA(5)+AREA(6)
  27   IF((AREA1-AREA2).NE.0.0)GO TO 28
       VOLUME = (XQ(2)-XQ(1))*(YQ(3)-YQ(2))*(ZQ(1)-ZQ(5))
       GO TO 30
  28   WRITE(PT,29)IL
  30   DO 32 I=1,NCUBE
  29   FORMAT(/12X,'ELEMENT NO. ',I3,'  HAS NEGATIVE AREA')
  32   SILJC(I) = 0.0
       NX2 = NCUBE*NCUBE
       DO 33 I  = 1,NX2
       SIJ(I)= 0.0
       SKJ(I)= 0 0
       SLJ(I)= 0.0
       WKX(I)= 0.0
       WKY(I)= 0.0
       WKZ(I)= 0.0
       SIKJO(I)= 0.0
       DSFX(I) = 0.0
       DSFY(I) = 0.0
       DSFZ(I) = 0.0
  33   CONTINUE
       NX3=NX2*NCUBE
       DO 34 I=1,NX3
       DNIDX(I)=0.0
       DNIDY(I)=0.0
       DNIDZ(I)=0.0
  34   CONTINUE
       DO 35 I=1,3
  35   AA(I)=1.D0
       THIRD=1.D0/3.D0
       THIRD2=2.D0/3.D0
       R964 =9.D0/64.D0
       R1972=19.D0/72.D0
       DO 75 KX =1,NORDER
       YP=GQPO(KX)
       WZ=GQWT(KX)
       DO 75 KT =1,NORDER
       ET=GQPO(KT)
       WS=GQWT(KT)*WZ
       DO 75 KN =1,NORDER
       ZT=GQPO(KN)
       W=WS*GQWT(KN)
```

```
      IF(KT.NE.1)GO TO 74
      IF(KN.NE.1)GO TO 74
      SNI=SFV(I)
      XX=XX+SNI*XQ(I)
      YY=YY+YQ(I)*SNI
      ZZ=ZZ+ZQ(I)*SNI
      WTAV=SFV(I)
      IF(NORDER.EQ.2)GO TO 74
      DSFXN(II)=F(I)
      DSFYN(II)=FY(I)
      DSFZN(II)=FZ(I)
   74 CONTINUE
   75 CONTINUE
      ET =0.
      ZT =0.
      YP =0
      II = 1
C
      CALL GLOBAL(NCUBE,II)
   79 FORMAT(////,I3,5X,3F11.4/(40X,I2,3F11.4))
   80 CONTINUE
      RETURN
      END
C     ****************************************************
      SUBROUTINE GLOBAL(NCUBE,II)
C
C     PURPOSE:THIS SUBROUTINE ASSEMBLE ELEMENT MATRICES INTO THE
C     GLOBAL SYSTEM
C     ****************************************************
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBA/SIJ(400),SKJ(400),SLJ(400),SMJ(400),SWJ(400),
     1SOJ(400),SIKJO(200),SILJC(200),DNIDX(2000),DNIDY(2000),
     2DNIDZ(2000),WKX(400),WKY(400),WKZ(400),DXX(400),DYY(400),
     3DZZ(400),VLX(400),VLY(400),VLZ(400),XQ(8),YQ(8),ZQ(8),AA(3)
      COMMON /SUBB/AA1(8),AA2(8),AA3(8),DSFXN(64),DSFYN(64),
     1DSFZN(64),DSFX(64),DSFY(64),DSFZ(64),ETA(36),PHY(36),
     2ZETA(64),SA(6),SFV(8),FX(8),FY(8),FZ(8),F(24),G(24),H(24),
     3GQPU(5),GQWT(5),SS(6),DD(6),NODD(8),MATNO(8),MNO(8)
      COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      COMMON /SUBF/C(400),CINT(400),COLD(400),QW(400),BCD(8)
C
      DO 5 I = 1,NCUBE
      DO 5 J = 1,NCUBE
      TA=WKX(II)*VLX(NODD(J))+WKY(II)*VLY(NODD(J))+WKZ(II)*(NODD(J))
      TB=DNIDX(II)*VLX(NODD(J))+DNIDY(II)*VLY(NODD(J))+DNIDZ(II)*VLZ(
     1NODD(J))
      TC=SIJ(II)*DXX(NODD(J))+SLJ(II)*DYY(NODD(J))+SKJ(II)*DZZ(NODD(J))
      P(I,J)=TA+TB+TC
      COEFF=1
      R(I,J) =COEFF*SIKJO(II)
      II =II+1
      GLOBMX(NODD(I),NODD(J))=GLOBMX(NODD(I),NODD(J))+P(I,J)
      STOMX(NODD(I),NODD(J))=STOMX(NODD(I),NODD(J))+R(I,J)
      RMX(NODD(I)) = RMX(NODD(I))+SILJC(I)*QW(NODD(I))
    5 CONTINUE
      RETURN
      END
C     ****************************************************
      SUBROUTINE BOUND(MXNOD,DELT,NDBC,NSTEDY)
C
C     PURPOSE THIS SUBROUTINE MODIFIES THE GLOBAL MATRIX WITH KNOWN
C     BOUNDARY CONDITIONS
C     ****************************************************
C
```

```
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      COMMON /SUBF/C(400),CINT(400),COLD(400),QW(400),BCD(8)
      COMMON /SUBG/ID(400),ND(400)
C     ------------------------------------------------------------
C
      DO 5 I = 1,MXNOD
      DO 5 J = 1,MXNOD
      STOMX(I,J) = STOMX(I,J)/DELT
      GLOBMX(I,J) = GLOBMX(I,J)+FACT*STOMX(I,J)
    5 CONTINUE
      DO 25 I = 1,NDBC
      IF(ID(ND(I)) NE 1)GO TO 20
      DO 15 J = 1,MXNOD
      IF(J EQ.ND(I))GO TO 10
      GLOBMX(ND(I),J) = 0.0
C     -
      RMX(J) = RMX(J)+GLOBMX(J,ND(I))*CINT(ND(I))
      GLOBMX(J,ND(I)) = 0.0
      GO TO 15
   10 RMX(J) = GLOBMX(ND(I),ND(I))*CINT(ND(I))
   15 CONTINUE
      GO TO 728
   20 IF(ID(ND(I)).NE.0)GO TO 25
C     -
      RMX(ND(I)) = RMX(ND(I))+BCD(ND(I))
   25 CONTINUE
      DO 30 KS = 1,MXNOD
   30 COLD(KS) = CINT(KS)
      RETURN
      END
C     ************************************************************
      SUBROUTINE WIDTH(BANDW,IROW,MXNOD)
C
C     PURPOSE:THIS SUBROUTINE CALCULATES THE BANDWIDTH OF THE
C     GLOBAL MATRIX .
C     ************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
      MAX = 0
      DO 10  I = 1,MXNOD
      DO 5 J = 1,MXNOD
      IF(GLOBMX(I,J).EQ.0.0)GO TO 5
      BANDW = J-I
      IF(BANDW LE.MAX)GO TO 5
      MAX = BANDW
      IROW = I
    5 CONTINUE
      BANDW = 0
   10 CONTINUE
      BANDW = MAX
      BANDW = BANDW+1
      DO 20 I = 1,MXNOD
      DO 15 J = 1,BANDW
      IF(I+J-1.GT.MXNOD)GO TO 303
      GLOBMX(I,J) = GLOBMX(I,I+J-1)
      STOMX(I,J) = STOMX(I,I+J-1)
   15 CONTINUE
   20 CONTINUE
      RETURN
      END
C     ************************************************************
      SUBROUTINE ADJUST(MXNOD,BANDW)
C
```

```
C     PURPOSE:THIS SUBROUTINE DECOMPOSES THE MATRIX INTO AN UPPER
C     TRIANGULAR MATRIX USING THE GAUSSIAN ELEIMINATION PROCEDURES.
C     ***************************************************************
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      KA = MXNOD-1
      DO 15  I=1,KA
      KB = I+BANDW-1
      IF(KB GT.MXNOD)KB=MXNOD
      KC = I+1
      KD = BANDW
      IF((MXNOD-I+1) LT.BANDW)KD-MXNOD-I+1
      KE = 0
      DO 10 J= KC,KB
      KD = KD-1
      KE = KE+1
      KF = KE+1
      EM=GLOBMX(I,KF)/GLOBMX(I,1)
      IF(EM.EQ.0.0)GO TO 10
      DO 5 K-1,KD
      KG = KE+K
    5 GLOBMX(J,K)=GLOBMX(J,K)-EM*GLOBMX(I,KF)
   10 CONTINUE
   15 CONTINUE
      RETURN
      END
C     *************************************************
      SUBROUTINE RIGHTV(MXNOD,BANDW)
C
C     PURPOSE:THIS SUBROUTINE GENERATE RECT VECTOR AT EACH
C     TIME STEPS.
C     *************************************************
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      COMMON /SUBF/C(400),CINT(400),COLD(400),QW(400),BCD(8)
      DO 15 I=1,MXNOD
      SUM=0.0
      K=I-1
      DO 10 J-2,BANDW
      M=J+I-1
      IF(M.GT.MXNOD) GO TO 5
      SUM=SUM+STOMX(I,J)*COLD(M)
    5 IF(K.LE.0) GO TO 10
      SUM=SUM+STOMX(K,J)*COLD(K)
      K-K-1
   10 CONTINUE
   15 RECT(I)=SUM+STOMX(I,1)*COLD(I)
      RETURN
      END
C     ***************************************************************
      SUBROUTINE SOLVER(MXNOD,BANDW,NDBC)
C
C     PURPOSE:THIS SUBROUTINE SOLVES THE SYSTEM EQUATIONS
C     USING BACKWARD SUBSTITUTION.
C     ***************************************************************
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON /SUBC/STOMX(400,400),P(400,400),R(400,400)
      COMMON /SUBD/GLOBMX(400,400),RMX(400),RECT(400)
      COMMON /SUBF/C(400),CINT(400),COLD(400),QW(400),BCD(8)
      COMMON /SUBG/ID(400),ND(400)
      KA = MXNOD-1
      DO 5 I=1,KA
```

```
      KB = I+BANDW-1
      IF(KB.GT.MXNOD)KB=MXNOD
      KC = I+1
      L=1
      DO 5 J = NJ,MJ
      L=L+1
      RECT(J)=RECT(J)-GLOBMX(I,L)*RECT(I)/GLOBMX(I,1)
    5 CONTINUE
      C(MXNOD) = RECT(MXNOD)/GLOBMX(MXNOD,1)
      DO 15 K=1,KA
      I = MXNOD-K
      KB = BANDW
      IF((I+BANDW-1).GT.MXNOD)KB=MXNOD-I+1
      SUM = 0.0
      DO 10 J=2,KB
      N = I+J-1
      IF(N.GT.MXNOD)GO TO 15
   10 SUM=SUM+GLOBMX(I,J)*C(N)
   15 C(I) = (RECT(I)-SUM)/GLOBMX(I,1)
      DO  25 I=1,MXNOD
      DO  20 JK=1,NDBC
      IF (ND(JK).EQ.I)C(I)=CINI(I)
   20 CONTINUE
   25 CONTINUE
C
      RETURN
      END
$ENTRY
$IBSYS
//
```

APPENDIX B

GUIDE FOR DATA INPUT

This group of cards, which are read by the main program and input subroutine, contains data required to dimension the model. The reader should refer to Appendix A for the definition of the variables.

Card	Column	Format	Variable
1	1-4	I4	NELMS
	5-8	I4	MNOPE
	9-12	I4	NSTEDY
	13-16	I4	NDBC
	17-26	F10.2	DELT
2	1-11	nD11.3	VLX(I)
	12-23	nD11.3	VLY(I)
	24-34	nD11.3	VLZ(I)
3	1-11	nD11.3	DXX(I)
	12-23	nD11.3	DYY(I)
	24-34	nD11.3	DZZ(I)
4	1-4	I4	NWELLS
	5-8	I4	NPERS
	9-12	I4	NOMAT
	13-16	I4	NCE
	17-20	I4	IT
	21-30	F10.5	FACT
	31-40	F10.5	FACTA
5	1-10	D10.2	X(I)
	11-20	D10.2	y(I)
	21-30	D10.2	z(I)
	31-40	D10.2	QW(I)
	41-50	D10.2	CMT(I)

6	1-4	I4	NE
	5-40	8I4	NODE(I,J)
7	1-40	20I4	ND(I)
8	1-80	40I2	ID(I)

Note: Cards 2 and 3, with no specification, depend on how many nodes, one set for each node is needed for each card. For card 5, each element requires a card. For cards 7 and 8, if nodes are more than specified in the above table, an additional card is required.

APPENDIX C

INPUT/OUTPUT OF ONE-DIMENSIONAL TESTING

20, 50, 70, AND 100 ELEMENT TESTINGS

20 Elements

```
                    INPUT DATA FOR THREE-DIMENSIONAL
                    -------------------------- -----
                 GROUNDWATER DISP BY FINITE ELEMENT METHOD
                 -----------------------------------------

TOTAL NO  OF ELEMENTS              =  20
TOTAL NO  OF NODES                 =  60
MAXIMUM NO  OF NODES PER ELEMENT   =   8
TOTAL NO. OF MATERIALS             =   1
NUMBER OF PUMPING WELLS            =   0
NUMBER OF CONCS TO BE ESTIMATED    =  54



NUMBER OF PUMPING PERIODS          =   0
TOTAL SIMULATION PERIODS           =   5
FACTOR MULTIPLYING COMPUTED CONCS  =   1 00000



STEP SIZE                          =  10 00000
STATE OF PROBLEM                   =   1
NO  OF SPECIFIED CONDITIONS        =  36
```

```
                          NODE-ELEMENT RELATIONSHIP

ELEMS     N1      N2      N3      N4      N5      N6      N7      N8

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



                          FIXED BOUNDARY CONDITIONS

NODE     ID       NODE     ID       NODE     ID       NODE     ID       NODE     ID

   1      0          2      0          3      0          4      0          5      0
   6      0          7      1         12      0         13      1         18      0
  19      1         24      0         25      0         26      0         27      0
  28      0         29      0         30      0         31      0         32      0
  33      0         34      0         35      0         36      0         37      1
  42      0         43      1         48      0         49      1         54      0
  55      0         56      0         57      0         58      0         59      0
  60      0



                   MAXIMUM BANDWIDTH =  38 ON ROW NO   1
```

```
            COORDINATES AND INITIAL CONCS OF NODES (L)

NODES      Y(I)          X(I)          Z(I)          CIN(I)

   1     0 000 00      0 000 00      0 100 03      0 000 00           48     0 100 03      0 350 02      0 000 00      0 000 00
   2     0 200 02      0 000 00      0 100 03      0.000 00           49     0 000 00      0 500 02      0 000 00      0 100 01
   3     0 400 02      0 000 00      0 100 03      0 000 00           50     0 200 02      0.500 02      0 000 00      0 000 00
   4     0 600 02      0 000 00      0.100 03      0 000 00           51     0 400 02      0 500 02      0 000 00      0 000 00
   5     0 800 02      0 000 00      0 100 03      0 000 00           52     0 600 02      0.500 02      0 000 00      0 000 00
   6     0 100 03      0 000 00      0 100 03      0 000 00           53     0 800 02      0 500 02      0 000 00      0 000 00
   7     0 000 00      0.200 02      0 100 03      0 100 01           54     0 100 03      0 500 02      0 000 00      0 000 00
   8     0.200 02      0 200 02      0 100 03      0 000 00           55     0 000 00      0.700 02      0 000 00      0 000 00
   9     0 400 02      0.200 02      0.100 03      0 000 00           56     0 200 02      0 700 02      0 000 00      0 000 00
  10     0 600 02      0 200 02      0.100 03      0.000 00           57     0 400 02      0.700 02      0 000 00      0 000 00
  11     0 800 02      0.200 02      0.100 03      0 000 00           58     0 600 02      0 700 02      0 000 00      0 000 00
  12     0.100 03      0 200 02      0.100 03      0.000 00           59     0 800 02      0 700 02      0 000 00      0 000 00
  13     0 000 00      0.350 02      0 100 03      0 100 01           60     0 100 03      0 700 02      0 000 00      0 000 00
  14     0 200 02      0 350 02      0 100 03      0 000 00
  15     0 400 02      0 350 02      0 100 03      0 000 00
  16     0 600 02      0 350 02      0 100 03      0 000 00
  17     0 800 02      0 350 02      0 100 03      0 000 00
  18     0 100 03      0.350 02      0 100 03      0 000 00
  19     0 000 00      0.500 02      0.100 03      0 100 01
  20     0 200 02      0 500 02      0.100 03      0 000 00
  21     0.400 02      0 500 02      0.100 03      0.000 00
  22     0 600 02      0 500 02      0.100 03      0 000 00
  23     0 800 02      0 500 02      0 100 03      0.000 00
  24     0 100 03      0.500 02      0 100 03      0.000 00
  25     0 000 00      0 700 02      0.100 03      0.000 00
  26     0 200 02      0 700 02      0.100 03      0 000 00
  27     0 400 02      0 700 02      0.100 03      0 000 00
  28     0 600 02      0.700 02      0 100 03      0 000 00
  29     0 800 02      0 700 02      0.100 03      0 000 00
  30     0 100 03      0 700 02      0 100 03      0 000 00
  31     0 000 00      0 000 00      0 000 00      0.000 00
  32     0.200 02      0 000 00      0 000 00      0.000 00
  33     0 400 02      0 000 00      0 000 00      0 000 00
  34     0 600 02      0.000 00      0.000 00      0 000 00
  35     0 800 02      0 000 00      0 000 00      0.000 00
  36     0 100 03      0 000 00      0 000 00      0 000 00
  37     0 000 00      0.200 02      0 000 00      0 100 01
  38     0 200 02      0 200 02      0 000 00      0 000 00
  39     0 400 02      0 200 02      0 000 00      0 000 00
  40     0 600 02      0 200 02      0 000 00      0 000 00
  41     0 800 02      0 200 02      0 000 00      0 000 00
  42     0 100 03      0 200 02      0 000 00      0 000 00
  43     0 000 00      0 350 02      0 000 00      0 100 01
  44     0 200 02      0 350 02      0 000 00      0 000 00
  45     0 400 02      0 350 02      0 000 00      0 000 00
  46     0 600 02      0 350 02      0 000 00      0 000 00
  47     0 800 02      0 350 02      0 000 00      0 000 00
```

```
                        OUTPUT FOR THREE-DIMENSIONAL
                        ----------------------------
                  GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                  ------------------------------------------

                  INITIAL CONC DISTRIBUTION AT TIME =   0.000 DAYS

NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS

    1     0.0000D 00      2     0.0000D 00      3     0.0000D 00      4     0.0000D 00      5     0.0000D 00
    6     0.0000D 00      7     0.0000D 00      8     0.0000D 00      9     0.0000D 00     10     0.0000D 00
   11     0.0000D 00     12     0.0000D 00     13     0.0000D 00     14     0.0000D 00     15     0.0000D 00
   16     0.0000D 00     17     0.0000D 00     18     0.0000D 00     19     0.0000D 00     20     0.0000D 00
   21     0.0000D 00     22     0.0000D 00     23     0.0000D 00     24     0.0000D 00     25     0.0000D 00
   26     0.0000D 00     27     0.0000D 00     28     0.0000D 00     29     0.0000D 00     30     0.0000D 00
   31     0.0000D 00     32     0.0000D 00     33     0.0000D 00     34     0.0000D 00     35     0.0000D 00
   36     0.0000D 00     37     0.0000D 00     38     0.0000D 00     39     0.0000D 00     40     0.0000D 00
   41     0.0000D 00     42     0.0000D 00     43     0.0000D 00     44     0.0000D 00     45     0.0000D 00
   46     0.0000D 00     47     0.0000D 00     48     0.0000D 00     49     0.0000D 00     50     0.0000D 00
   51     0.0000D 00     52     0.0000D 00     53     0.0000D 00     54     0.0000D 00     55     0.0000D 00
   56     0.0000D 00     57     0.0000D 00     58     0.0000D 00     59     0.0000D 00     60     0.0000D 00


                  INITIAL CONC DISTRIBUTION AT TIME =  10.000 DAYS

NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS

    1     0.0000D 00      2     0.0000D 00      3     0.473D-03      4     0.500D-03      5     0.170D-03
    6     0.0000D 00      7     0.100D 01      8     0.661D 00      9     0.579D 00     10     0.514D 00
   11     0.481D 00     12     0.404D 00     13     0.100D 01     14     0.508D 00     15     0.288D 00
   16     0.137D 00     17     0.539D-01     18     0.184D-01     19     0.100D 01     20     0.661D 00
   21     0.579D 00     22     0.514D 00     23     0.481D 00     24     0.404D 00     25     0.0000D 00
   26     0.0000D 00     27     0.470D-03     28     0.500D-03     29     0.170D-02     30     0.0000D 00
   31     0.0000D 00     32     0.0000D 00     33     0.473D-03     34     0.500D-03     35     0.170D-03
   36     0.0000D 00     37     0.100D 01     38     0.661D 00     39     0.579D 00     40     0.514D 00
   41     0.481D 00     42     0.404D 00     43     0.100D 01     44     0.508D 00     45     0.288D 00
   46     0.137D 00     47     0.539D-01     48     0.184D-01     49     0.100D 01     50     0.661D 00
   51     0.579D 00     52     0.514D 00     53     0.481D 00     54     0.404D 00     55     0.0000D 00
   56     0.0000D 00     57     0.470D-03     58     0.500D-03     59     0.170D-03     60     0.0000D 00
```

```
                              INITIAL CONC DISTRIBUTION AT TIME =  20 000 DAYS
NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

   1    0 000D 00      2    0.114D-01      3    0 291D-01      4    0 360D-01      5    0 329D-01
   6    0 244D-01      7    0.100D 01      8    0.724D 00      9    0 670D 00     10    0 400D 06
  11    0 571D 00     12    0 588D 00     13    0.100D 01     14    0.590D 00     15    0 500D 06
  16    0 276D 00     17    0 171D 00     18    0.101D 00     19    0 100D 01     20    0 724D 00
  21    0 674D 00     22    0 618D 00     23    0 571D 00     24    0.550D 00     25    0 800D 06
  26    0 114D-01     27    0 291D-01     28    0.360D-01     29    0 329D-01     30    0 244D-01
  31    0 000D 00     32    0 114D-01     33    0.291D-01     34    0 360D-01     35    0 329D-01
  36    0 244D-01     37    0 100D 01     38    0 724D 00     39    0 670D 00     40    0 400D 06
  41    0 571D 00     42    0 588D 00     43    0 100D 01     44    0 590D 00     45    0 500D 06
  46    0 276D 00     47    0 171D 00     48    0.101D 00     49    0 100D 01     50    0 724D 00
  51    0 674D 00     52    0 618D 00     53    0 571D 00     54    0 550D 00     55    0 800D 06
  56    0 114D-01     57    0 291D-01     58    0.360D-01     59    0.329D-01     60    0 244D-01


                              INITIAL CONC DISTRIBUTION AT TIME =  30.000 DAYS
NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

   1    0 000D 00      2    0.232D-01      3    0.549D-01      4    0 723D-01      5    0 736D-01
   6    0 649D-01      7    0.100D 01      8    0.762D 00      9    0 729D 00     10    0 688D 00
  11    0 645D 00     12    0 625D 00     13    0 100D 01     14    0.735D 00     15    0 484D 00
  16    0 356D 00     17    0 253D 00     18    0.180D 00     19    0 100D 01     20    0 762D 00
  21    0 729D 00     22    0 688D 00     23    0 645D 00     24    0 625D 00     25    0 000D 00
  26    0 232D-01     27    0 549D-01     28    0.723D-01     29    0 736D-01     30    0 649D-01
  31    0 000D 00     32    0 232D-01     33    0 549D-01     34    0 723D-01     35    0 736D-01
  36    0 619D-01     37    0 100D 01     38    0 762D 00     39    0 729D 00     40    0 688D 00
  41    0 645D 00     42    0 625D 00     43    0 100D 01     44    0.735D 00     45    0 484D 00
  46    0 356D 00     47    0 253D 00     48    0 180D 00     49    0 100D 01     50    0 762D 00
  51    0 729D 00     52    0 688D 00     53    0 645D 00     54    0 625D 00     55    0 000D 00
  56    0 232D-01     57    0 549D-01     58    0 723D-01     59    0 736D-01     60    0 649D-01
```

```
                      INITIAL CONC DISTRIBUTION AT TIME =  40.000 DAYS
NODES   CONCS      NODES   CONCS      NODES   CONCS      NODES   CONCS      NODES   CONCS

  1   0 000D 00      2   0.340D-01     3   0.762D-01     4   0.104D 00     5   0.113D 00
  6   0.109D 00      7   0.1000 01     8   0.749D 00     9   0 7700 00    10   0.7400 00
 11   0 705D 00     12   0.684D 00    13   0.100D 01    14   0.699D 00    15   0 525D 00
 16   0 407D 00     17   0.313D 00    18   0.241D 00    19   0.100D 01    20   0 794D 00
 21   0 7700 00     22   0.7400 00    23   0 705D 00    24   0 684D 00    25   0.000D 00
 26   0 340D-01     27   0 762D-01    28   0.104D 00    29   0.113D 00    30   0.109D 00
 31   0 000D 00     32   0.340D-01    33   0.762D-01    34   0.104D 00    35   0.113D 00
 36   0 109D 00     37   0 100D 01    38   0.749D 00    39   0.7700 00    40   0.740D 00
 41   0 705D 00     42   0 684D 00    43   0.100D 01    44   0 699D 00    45   0 525D 00
 46   0 407D 00     47   0.313D 00    48   0.241D 00    49   0 100D 01    50   0 794D 00
 51   0 770D 00     52   0 7400 00    53   0.705D 00    54   0.684D 00    55   0.00CD 00
 56   0 340D-01     57   0.762D-01    58   0.104D 00    59   0.1130 00    60   0.109D 00
```

```
                      INITIAL CONC DISTRIBUTION AT TIME =  50 000 DAYS
NODES   CONCS      NODES   CONCS      NODES   CONCS      NODES   CONCS      NODES   CONCS

  1   0 000D 00      2   0 433D-01     3   0.945D-01     4   0 131D 00     5   0.147D 00
  6   0 150D 00      7   0.100D 01     8   0 843D 00     9   0 801D 00    10   0 782D 00
 11   0 755D 00     12   0 734D 00    13   0.100D 01    14   0 693D 00    15   0 554D 00
 16   0 446D 00     17   0 359D 00    18   0 297D 00    19   0 100D 01    20   0 843D 00
 21   0 801D 00     22   0 782D 00    23   0 755D 00    24   0.734D 00    25   0 000D 00
 26   0 433D-01     27   0 945D-01    28   0 131D 00    29   0 145D 00    30   0 15CD 00
 31   0 000D 00     32   0 433D-01    33   0 945D-01    34   0 131D 00    35   0 147D 00
 36   0 15CD 00     37   0 100D 01    38   0 843D 00    39   0 801D 00    40   0 782D 00
 41   0 755D 00     42   0 734D 00    43   0 100D 01    44   0 693D 00    45   0 554D 00
 46   0 446D 00     47   0 359D 00    48   0 297D 00    49   0 100D 01    50   0 843D 00
 51   0 801D 00     52   C 782D 00    53   0 755D 00    54   0 734D 00    55   0 000D 00
 56   0 433D-01     57   0 945D-01    58   0.131D 00    59   0 145D 00    60   0 15CD 00
```

50 Elements

```
                    INPUT DATA FOR THREE-DIMENSIONAL
                    --------------------------------
                GROUNDWATER DISP BY FINITE ELEMENT METHOD
                -----------------------------------------


TOTAL NO  OF ELEMENTS                = 50
TOTAL NO  OF NODES                   = 132
MAXIMUM NO  OF NODES PER ELEMENT     =   8
TOTAL NO  OF MATERIALS               =   1
NUMBER OF PUMPING WELLS              =   0
NUMBER OF CONCS TO BE ESTIMATED      = 124




NUMBER OF PUMPING PERIODS            =   0
TOTAL SIMULATION PERIODS             =   5
FACTOR MULTIPLYING COMPUTED CONCS =      1 00000




STEP SIZE                            =  10 00000
STATE OF PROBLEM                     =   1
NO  OF SPECIFIED CONDITIONS          =  60
```

```
                 COORDINATES AND INITIAL CONCS OF NODES (L)

NODES       Y(I)          X(I)          Z(I)          CINT(I)

   1     0.000D 00     0.000D 00     0.100D 03     0.000D 00
   2     0.100D 02     0.000D 00     0.100D 03     0.000D 00
   3     0.200D 02     0.000D 00     0.100D 03     0.000D 00
   4     0.300D 02     0.000D 00     0.100D 03     0.000D 00
   5     0.400D 02     0.000D 00     0.100D 03     0.000D 00
   6     0.500D 02     0.000D 00     0.100D 03     0.000D 00
   7     0.600D 02     0.000D 00     0.100D 03     0.000D 00
   8     0.700D 02     0.000D 00     0.100D 03     0.000D 00
   9     0.800D 02     0.000D 00     0.100D 03     0.000D 00
  10     0.900D 02     0.000D 00     0.100D 03     0.000D 00
  11     0.100D 03     0.000D 00     0.100D 03     0.000D 00
  12     0.000D 00     0.200D 02     0.100D 03     0.100D 01
  13     0.100D 02     0.200D 02     0.100D 03     0.000D 00
  14     0.200D 02     0.200D 02     0.100D 03     0.000D 00
  15     0.300D 02     0.200D 02     0.100D 03     0.000D 00
  16     0.400D 02     0.200D 02     0.100D 03     0.000D 00
  17     0.500D 02     0.200D 02     0.100D 03     0.000D 00
  18     0.600D 02     0.200D 02     0.100D 03     0.000D 00
  19     0.700D 02     0.200D 02     0.100D 03     0.000D 00
  20     0.800D 02     0.200D 02     0.100D 03     0.000D 00
  21     0.900D 02     0.200D 02     0.100D 03     0.000D 00
  22     0.100D 03     0.200D 02     0.100D 03     0.000D 00
  23     0.000D 00     0.350D 02     0.100D 03     0.100D 01
  24     0.100D 02     0.350D 02     0.100D 03     0.000D 00
  25     0.200D 02     0.350D 02     0.100D 03     0.000D 00
  26     0.300D 02     0.350D 02     0.100D 03     0.000D 00
  27     0.400D 02     0.350D 02     0.100D 03     0.000D 00
  28     0.500D 02     0.350D 02     0.100D 03     0.000D 00
  29     0.600D 02     0.350D 02     0.100D 03     0.000D 00
  30     0.700D 02     0.350D 02     0.100D 03     0.000D 00
  31     0.800D 02     0.350D 02     0.100D 03     0.000D 00
  32     0.900D 02     0.350D 02     0.100D 03     0.000D 00
  33     0.100D 03     0.350D 02     0.100D 03     0.000D 00
  34     0.000D 00     0.400D 02     0.100D 03     0.100D 01
  35     0.100D 02     0.400D 02     0.100D 03     0.000D 00
  36     0.200D 02     0.400D 02     0.100D 03     0.000D 00
  37     0.300D 02     0.400D 02     0.100D 03     0.000D 00
  38     0.400D 02     0.400D 02     0.100D 03     0.000D 00
  39     0.500D 02     0.400D 02     0.100D 03     0.000D 00
  40     0.600D 02     0.400D 02     0.100D 03     0.000D 00
  41     0.700D 02     0.400D 02     0.100D 03     0.000D 00
  42     0.800D 02     0.400D 02     0.100D 03     0.000D 00
  43     0.900D 02     0.400D 02     0.100D 03     0.000D 00
  44     0.100D 03     0.400D 02     0.100D 03     0.000D 00
  45     0.000D 00     0.500D 02     0.100D 03     0.100D 01
  46     0.100D 02     0.500D 02     0.100D 03     0.000D 00
  47     0.200D 02     0.500D 02     0.100D 03     0.000D 00
```

```
 48    0 300 02    0 500 02    0.100 03    0.000 00
 49    0 400 02    0.500 02    0.100 03    0.000 00
 50    0 500 02    0 500 02    0.100 03    0.000 00
 51    0 600 02    0.500 02    0.100 03    0.000 00
 52    0.700 02    0.500 02    0.100 03    0 000 00
 53    0.800 02    0.500 02    0.100 03    0 000 00
 54    0.900 02    0.500 02    0.100 03    0.000 00
 55    0 100 03    0 500 02    0.100 03    0 000 00
 56    0.000 00    0 700 02    0.100 03    0 000 00
 57    0 100 02    0.700 02    0 100 03    0.000 00
 58    0.200 02    0.700 02    0 100 03    0 000 00
 59    0 300 02    0.700 02    0.100 03    0.000 00
 60    0.400 02    0.700 02    0.100 03    0.000 00
 61    0.500 02    0.700 02    0.100 03    0.000 00
 62    0 600 02    0.700 02    0.100 03    0.000 00
 63    0.700 02    0.700 02    0.100 03    0.000 00
 64    0 800 02    0 700 02    0.100 03    0.000 00
 65    0.900 02    0.700 02    0.100 03    0.000 00
 66    0.100 03    0.700 02    0.100 03    0.000 00
 67    0.000 00    0.000 00    0.000 00    0.000 00
 68    0.100 02    0.000 00    0.000 00    0 000 00
 69    0.200 02    0.000 00    0.000 00    0.000 00
 70    0 300 02    0.000 00    0.000 00    0 000 00
 71    0.400 02    0.000 00    0.000 00    0 000 00
 72    0 500 02    0.000 00    0.000 00    0 000 00
 73    0.600 02    0.000 00    0.000 00    0.000 00
 74    0 700 02    0.000 00    0.000 00    0.000 00
 75    0.800 02    0.000 00    0.000 00    0 000 00
 76    0.900 02    0.000 00    0.000 00    0.000 00
 77    0 100 03    0.000 00    0.000 00    0.000 00
 78    0.000 00    0.200 02    0.000 00    0.100 01
 79    0.100 02    0.200 02    0.000 00    0.000 00
 80    0.200 02    0.200 02    0.000 00    0.000 00
 81    0.300 02    0.200 02    0.000 00    0.000 00
 82    0 400 02    0.200 02    0.000 00    0.000 00
 83    0 500 02    0.200 02    0.000 00    0 000 00
 84    0.600 02    0.200 02    0.000 00    0.000 00
 85    0.700 02    0.200 02    0.000 00    0.000 00
 86    0.800 02    0 200 02    0.000 00    0.000 00
 87    0 900 02    0.200 02    0.000 00    0.000 00
 88    0.100 03    0.200 02    0.000 00    0.000 00
 89    0 000 00    0.350 01    0.000 00    0.100 01
 90    0.100 02    0.350 02    0.000 00    0 000 00
 91    0 200 02    0 350 02    0.000 00    0.000 00
 92    0 300 02    0.350 02    0.000 00    0.000 00
 93    0 400 02    0.350 02    0 000 00    0.000 00
 94    0.500 02    0.350 02    0.000 00    0 000 00
 95    0.600 02    0.350 02    0.000 00    0.000 00
 96    0.700 02    0.350 02    0.000 00    0.000 00
 97    0.800 02    0 350 02    0.000 00    0 000 00
 98    0 900 02    0.350 02    0 000 00    0 000 00
 99    0.100 03    0 350 02    0.000 00    0.000 00
100    0.000 00    0 400 02    0.000 00    0 100 01
101    0 100 02    0.400 02    0 000 00    0.000 00
102    0 200 02    0 400 02    0.000 00    0 000 00
103    0 300 02    0.400 02    0.000 00    0.000 00
104    0 400 02    0 400 02    0.000 00    0 000 00
105    0 500 02    0 400 02    0.000 00    0 000 00
106    0 600 02    0 400 02    0 000 00    0 000 00
107    0 700 02    0 400 02    0.000 00    0 000 00
```

```
108    0.800 02    0 400 02    0 000 00    0 000 00
109    0.900 02    0.400 02    0 000 00    0 000 00
110    0 100 03    0.400 02    0 000 00    0 000 00
111    0 000 00    0.500 02    0.000 00    0 100 01
112    0.100 02    0.500 02    0 000 00    0.000 00
113    0.200 02    0.500 02    0.000 00    0.000 00
114    0 300 02    0.500 02    0 000 00    0 000 00
115    0 400 02    0.500 02    0 000 00    0 000 00
116    0.500 02    0.500 02    0 000 00    0 000 00
117    0 600 02    0.500 02    0.000 00    0 000 00
118    0 700 02    0.500 02    0 000 00    0 000 00
119    0 800 02    0 500 02    0 000 00    0 000 00
120    0.900 02    0 500 02    0 000 C0    0 000 00
121    0.100 03    0.500 02    0 000 C0    0.000 00
122    0 000 00    0 700 02    0 000 00    0 000 00
123    0.100 02    0.700 02    0 000 00    0 000 00
124    0.200 02    0.700 02    0 000 00    0 000 00
125    0 300 02    0.700 02    0 000 00    0 000 00
126    0.400 02    0.700 02    0 000 00    0.000 00
127    0 500 02    0.700 02    0.000 00    0.000 00
128    0.600 02    0.700 02    0.000 00    0 000 00
129    0.700 02    0.700 02    0.000 00    0.000 00
130    0.800 02    0.700 02    0 000 00    0.000 00
131    0.900 02    0.700 02    0.000 00    0 000 00
132    0.100 03    0.700 02    0 000 00    0 000 00
```

NODE-ELEMENT RELATIONSHIP

ELEMS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	2	13	12	67	68	79	78
2	2	3	14	13	68	69	80	79
3	3	4	15	14	69	70	81	80
4	4	5	16	15	70	71	82	81
5	5	6	17	16	71	72	83	82
6	6	7	18	17	72	73	84	83
7	7	8	19	18	73	74	85	84
8	8	9	20	19	74	75	86	85
9	9	10	21	20	75	76	87	86
10	10	11	22	21	76	77	88	87
11	12	13	24	23	78	79	90	89
12	13	14	25	24	79	80	91	90
13	14	15	26	25	80	81	92	91
14	15	16	27	26	81	82	93	92
15	16	17	28	27	82	83	94	93
16	17	18	29	28	83	84	95	94
17	18	19	30	29	84	85	96	95
18	19	20	31	30	85	86	97	96
19	20	21	32	31	86	87	98	97
20	21	22	33	32	87	88	99	98
21	23	24	35	34	89	90	101	100
22	24	25	36	35	90	91	102	101
23	25	26	37	36	91	92	103	102
24	26	27	38	37	92	93	104	103
25	27	28	39	38	93	94	105	104
26	28	29	40	39	94	95	106	105
27	29	30	41	40	95	96	107	106
28	30	31	42	41	96	97	108	107
29	31	32	43	42	97	98	109	108
30	32	33	44	43	98	99	110	109
31	34	35	46	45	100	101	112	111
32	35	36	47	46	101	102	113	112
33	36	37	48	47	102	103	114	113
34	37	38	49	48	103	104	115	114
35	38	39	50	49	104	105	116	115
36	39	40	51	50	105	106	117	116
37	40	41	52	51	106	107	118	117
38	41	42	53	52	107	108	119	118
39	42	43	54	53	108	109	120	119
40	43	44	55	54	109	110	121	120
41	45	46	57	56	111	112	123	122
42	46	47	58	57	112	113	124	123
43	47	48	59	58	113	114	125	124
44	48	49	60	59	114	115	126	125
45	49	50	61	60	115	116	127	126
46	50	51	62	61	116	117	128	127

```
     47          51          52          63          62         117         118         129         128
     48          52          53          64          63         118         119         130         129
     49          53          54          65          64         119         120         131         130
     50          54          55          66          65         120         121         132         131



                                        FIXED BOUNDARY CONDITIONS

   NODE       ID          NODE       ID          NODE       ID          NODE       ID          NODE       ID

      1        0             2        0             3        0             4        0             5        0
      6        0             7        0             8        0             9        0            10        0
     11        0            12        1            22        0            23        1            33        0
     34        1            44        0            45        1            55        0            56        0
     57        0            58        0            59        0            60        0            61        0
     62        0            63        0            64        0            65        0            66        0
     67        0            68        0            69        0            70        0            71        0
     72        0            73        0            74        0            75        0            76        0
     77        0            78        1            88        0            89        1            99        0
    100        1           110        0           111        1           121        0           122        0
    123        0           124        0           125        0           126        0           127        0
    128        0           129        0           130        0           131        0           132        0



                              MAXIMUM BANDWIDTH =  79 ON ROW NO.   1
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                         OUTPUT FOR THREE-DIMENSIONAL
                         ----------------------------
                    GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                    ------------------------------------------

                   INITIAL CONC DISTRIBUTION AT TIME =   0.000 DAYS

NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS

    1   0.000D 00       2   0.000D 00       3   0.000D 00       4   0.000D 00       5   0.000D 00
    6   0.000D 00       7   0.000D 00       8   0.000D 00       9   0.000D 00      10   0.000D 00
   11   0.000D 00      12   0.000D 00      13   0.000D 00      14   0.000D 00      15   0.000D 00
   16   0.000D 00      17   0.000D 00      18   0.000D 00      19   0.000D 00      20   0.000D 00
   21   0.000D 00      22   0.000D 00      23   0.000D 00      24   0.000D 00      25   0.000D 00
   26   0.000D 00      27   0.000D 00      28   0.000D 00      29   0.000D 00      30   0.000D 00
   31   0.000D 00      32   0.000D 00      33   0.000D 00      34   0.000D 00      35   0.000D 00
   36   0.000D 00      37   0.000D 00      38   0.000D 00      39   0.000D 00      40   0.000D 00
   41   0.000D 00      42   0.000D 00      43   0.000D 00      44   0.000D 00      45   0.000D 00
   46   0.000D 00      47   0.000D 00      48   0.000D 00      49   0.000D 00      50   0.000D 00
   51   0.000D 00      52   0.000D 00      53   0.000D 00      54   0.000D 00      55   0.000D 00
   56   0.000D 00      57   0.000D 00      58   0.000D 00      59   0.000D 00      60   0.000D 00
   61   0.000D 00      62   0.000D 00      63   0.000D 00      64   0.000D 00      65   0.000D 00
   66   0.000D 00      67   0.000D 00      68   0.000D 00      69   0.000D 00      70   0.000D 00
   71   0.000D 00      72   0.000D 00      73   0.000D 00      74   0.000D 00      75   0.000D 00
   76   0.000D 00      77   0.000D 00      78   0.000D 00      79   0.000D 00      80   0.000D 00
   81   0.000D 00      82   0.000D 00      83   0.000D 00      84   0.000D 00      85   0.000D 00
   86   0.000D 00      87   0.000D 00      88   0.000D 00      89   0.000D 00      90   0.000D 00
   91   0.000D 00      92   0.000D 00      93   0.000D 00      94   0.000D 00      95   0.000D 00
   96   0.000D 00      97   0.000D 00      98   0.000D 00      99   0.000D 00     100   0.000D 00
  101   0.000D 00     102   0.000D 00     103   0.000D 00     104   0.000D 00     105   0.000D 00
  106   0.000D 00     107   0.000D 00     108   0.000D 00     109   0.000D 00     110   0.000D 00
  111   0.000D 00     112   0.000D 00     113   0.000D 00     114   0.000D 00     115   0.000D 00
  116   0.000D 00     117   0.000D 00     118   0.000D 00     119   0.000D 00     120   0.000D 00
  121   0.000D 00     122   0.000D 00     123   0.000D 00     124   0.000D 00     125   0.000D 00
  126   0.000D 00     127   0.000D 00     128   0.000D 00     129   0.000D 00     130   0.000D 00
  131   0.000D 00     132   0.000D 00
```

```
                                   CONC DISTRIBUTION AT TIME =  10 000  DAYS
NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODFS      CONCS

    1    0 0000D 00       2    0.0000D 00       3    0 0000D 00       4    0 3500D-02       5    0 534D-02
    6    0 6300D-02       7    0.546D-02        8    0.367D-02        9    0 185D-02       10    0 9300D-03
   11    0 0000D 00      12    0 1000D 01      13    0 778D 00       14    0.723D 00       15    0 6600D 00
   16    0 612D 00       17    0 5700D 00      18    0.537D 00       19    0 512D 00       20    0 501D 00
   21    0.484D 00       22    0 477D 00       23    0 1000D 01      24    0 701D 00       25    0 555D 00
   26    0 417D 00       27    0.305D 00       28    0.213D 00       29    0 143D 00       30    0 908D-01
   31    0 555D-01       32    0.274D-01       33    0.5100D-03      34    0.1000D 01      35    0 688D 00
   36    0.535D 00       37    0.398D 00       38    0.288D 00       39    0 201D 00       40    0 134D 00
   41    0.853D-01       42    0.918D-01       43    0 298D-01       44    0 159D-01       45    0 1000D 01
   46    0 778D 00       47    0 723D 00       48    0 6600D 00      49    0 612D 00       50    0 5700D 00
   51    0 537D 00       52    0.912D 00       53    0.501D 00       54    0 484D 00       55    0 477D 00
   56    0 0000D 00      57    0 0000D 00      58    0.0000D 00      59    0 3500D-02      60    0 534D-02
   61    0 6300D-02      62    0.546D-02       63    0.367D-02       64    0 185D-02       65    0 9300D-03
   66    0 0000D 00      67    0.0000D 00      68    0.0000D 00      69    0 0000D 00      70    0.3500D-02
   71    0.534D-02       72    0 6300D-02      73    0.546D-02       74    0.367D-02       75    0 185D-02
   76    0.9300D-03      77    0.0000D 00      78    0.1000D 01      79    0.778D 00       80    0 723D 00
   81    0.6600D 00      82    0.612D 00       83    0.5700D 00      84    0 537D 00       85    0 912D 00
   86    0.501D 00       87    0.484D 00       88    0 477D 00       89    0 1000D 01      90    0 701D 00
   91    0.555D 00       92    0.417D 00       93    0.305D 00       94    0.213D 00       95    0 143D 00
   96    0.908D-01       97    0.555D-01       98    0.274D-01       99    0.5100D-03     100    0 1000D 01
  101    0 688D 00      102    0.535D 00      103    0.398D 00      104    0.288D 00      105    0 201D 00
  106    0.134D 00      107    0.853D-01      108    0.918D-01      109    0.298D-01      110    0 159D-01
  111    0.1000D 01     112    0.778D 00      113    0.723D 00      114    0 6600D 00     115    0 612D 00
  116    0 5700D 00     117    0.537D 00      118    0.912D 00      119    0 501D 00      120    0 484D 00
  121    0.477D 00      122    0.0000D 00     123    0.0000D 00     124    0 0000D 00     125    0 3500D-02
  126    0 534D-02      127    0.6300D-02     128    0.546D-02      129    0 367D-02      130    0 185D-02
  131    0.9300D-03     132    0.0000D 00
```

```
                                   CONC DISTRIBUTION AT TIME =  20.000 DAYS
NODES   CONCS       NODES   CONCS       NODES   CONCS       NODES   CONCS       NODES   CONCS

   1    0.000D 00      2    0.260D-02      3    0 123D-01      4    0 221D-01      5    0 305D-01
   6    0 362D-01      7    0.375D-01      8    0 368D-01      9    0.335D-01     10    0 280D-01
  11    0 234D-01     12    0 100D 01     13    0 840D 00     14    0 783D 00     15    0 741D 00
  16    0 705D 00     17    0 670D 00     18    0 636D 00     19    0 605D 00     20    0 581D 00
  21    0 556D 00     22    0.536D 00     23    0.100D 01     24    0 754D 00     25    0 643D 00
  26    0 535D 00     27    0.440D 00     28    0 356D 00     29    0 284D 00     30    0 223D 00
  31    0 173D 00     32    0.138D 00     33    0 974D-01     34    0.100D 01     35    0 739D 00
  36    0 619D 00     37    0.510D 00     38    0.418D 00     39    0.338D 00     40    0 269D 00
  41    0.212D 00     42    0.165D 00     43    0.124D 00     44    0.973D-01     45    0.100D 01
  46    0.840D 00     47    0.783D 00     48    0.741D 00     49    0.705D 00     50    0 670D 00
  51    0 636D 00     52    0 605D 00     53    0.581D 00     54    0 556D 00     55    0 536D 00
  56    0.000D 00     57    0.260D-02     58    0.123D-01     59    0 221D-01     60    0.305D-01
  61    0.362D-01     62    0.375D-01     63    0.368D-01     64    0.335D-01     65    0.208D-01
  66    0.234D-01     67    0.000D 00     68    0.260D-02     69    0.123D-01     70    0.221D-01
  71    0.305D-01     72    0.362D-01     73    0.375D-01     74    0 368D-01     75    0.335D-01
  76    0 280D-01     77    0.234D-01     78    0.100D 01     79    0.840D 00     80    0 783D 00
  81    0.741D 00     82    0.705D 00     83    0.670D 00     84    0 636D 00     85    0 605D 00
  86    0.581D 00     87    0.556D 00     88    0.536D 00     89    0 100D 01     90    0 754D 00
  91    0 643D 00     92    0.535D 00     93    0 440D 00     94    0 356D 00     95    0 284D 00
  96    0.223D 00     97    0.173D 00     98    0.138D 00     99    0.974D-01    100    0 100D 01
 101    0.739D 00    102    0.619D 00    103    0.510D 00    104    0 418D 00    105    0.338D 00
 106    0.269D 00    107    0.212D 00    108    0.165D 00    109    0.124D 00    110    0 973D-01
 111    0 100D 01    112    0.840D 00    113    0 783D 00    114    0 741D 00    115    0 705D 00
 116    0 670D 00    117    0.636D 00    118    0.605D 00    119    0 581D 00    120    0 556D 00
 121    0 536D 00    122    0 000D 00    123    0.260D-02    124    0 123D-01    125    0 221D-01
 126    0.305D-01    127    0.362D-01    128    0.375D-01    129    0 368D-01    130    0.335D-01
 131    0.208D-01    132    0.234D-01
```

```
                                   CONC DISTRIBUTION AT TIME =  30 000 DAYS
NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS

    1   0 0000D 00       2   0.8700-03       3   0.248D-01       4   0 4200-01       5   0 569D-01
    6   0 674D-01        7   0.734D 00       8   0 749D 00       9 • 0 740D-01      10   0 695D 01
   11   0 620D-01       12   0.1000 01      13   0 844D 00      14   0 815D 00      15   0 784D 00
   16   0 755D 00       17   0 727D 00      18   0 598D 00      19   0 672D 00      20   0 649D 00
   21   0 622D 00       22   0.598D 00      23   0.1000 01      24   0 779D 00      25   0 682D 00
   26   0 588D 00       27   0.502D 00      28   0.427D 00      29   0.377D 00      30   0 304D 00
   31   0 255D 00       32   0.210D 00      33   0.172D 00      34   0 1000 01      35   0 764D 00
   36   0 657D 00       37   0.561D 00      38   0.478D 00      39   0 407D 00      40   0 345D 00
   41   0.291D 00       42   0.244D 00      43   0.202D 00      44   0 165D 00      45   0 1000 01
   46   0 844D 00       47   0 815D 00      48   0 784D 00      49   0 755D 00      50   0 727D 00
   51   0 698D 00       52   0 672D 00      53   0 649D 00      54   0 622D 00      55   0 598D 00
   56   0.0000 00       57   0.8700-03      58   0.248D-01      59   0 4200-01      60   0 569D-01
   61   0.674D-01       62   0.734D 00      63   0.749D 00      64   0 740D-01      65   0 695D-01
   66   0.620D-01       67   0.0000 00      68   0.8700-03      69   0 248D-01      70   0 420D-01
   71   0 569D-01       72   0.674D-01      73   0.734D 00      74   0 749D 00      75   0 740D-01
   76   0.695D-01       77   0.620D-01      78   0.1000 01      79   0 844D 00      80   0 815D 00
   81   0.784D 00       82   0.755D 00      83   0.727D 00      84   0 698D 00      85   0 672D 00
   86   0 649D 00       87   0.622D 00      88   0 598D 00      89   0 1000 01      90   0 779D 00
   91   0.682D 00       92   0.588D 00      93   0.502D 00      94   0 427D 00      95   0 377D 00
   96   0.304D 00       97   0.255D 00      98   0.210D 00      99   0 172D 00     100   0 1000 01
  101   0.764D 00      102   0 657D 00     103   0.561D 00     104   0 478D 00     105   0 407D 00
  106   0 345D 00      107   0.291D 00     108   0.244D 00     109   0.202D 00     110   0 165D 00
  111   0 1000 01      112   0.844D 00     113   0.815D 00     114   0 784D 00     115   0 755D 00
  116   0.727D 00      117   0 698D 00     118   0.672D 00     119   0 649D 00     120   0 622D 00
  121   0 598D 00      122   0.0000 00     123   0.8700-03     124   0 248D-01     125   0 4200-01
  126   0 569D-01      127   0.674D-01     128   0.734D 00     129   0 749D 00     130   0 740D-01
  131   0 695D-01      132   0.620D-01
```

```
                                  CONC DISTRIBUTION AT TIME =  40 000  DAYS
NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

    1    0 0000 00        2    0.998D-02        3    0.358D-01        4    0 587D-01        5    0 781D-01
    6    0 944D-01        7    0 104D 00        8    0.111D 00        9    0.111D 00       10    0 110D 00
   11    0 104D 00       12    0.100D 01       13    0.861D 00       14    0 837D 00       15    0 815D 00
   16    0 789D 00       17    0 766D 00       18    0.741D 00       19    0 719D 00       20    0 705D 00
   21    0 678D 00       22    0.654D 00       23    0.100D 01       24    0 833D 00       25    0 706D 00
   26    0 645D 00       27    0.539D 00       28    0 490D 00       29    0 425D 00       30    0 371D 00
   31    0 326D 00       32    0.269D 00       33    0.230D 00       34    0 100D 01       35    0 782D 00
   36    0 680D 00       37    0.592D 00       38    0.519D 00       39    0 449D 00       40    0 391D 00
   41    0 342D 00       42    0.301D 00       43    0.271D 00       44    0 224D 00       45    0.100D 01
   46    0 861D 00       47    0.837D 00       48    0.815D 00       49    0 789D 00       50    0 766D 00
   51    0 741D 00       52    0.719D 00       53    0.705D 00       54    0 678D 00       55    0 654D 00
   56    0.000D 00       57    0.998D-02       58    0.358D-01       59    0 587D-01       60    0.781D-01
   61    0.944D-01       62    0.104D 00       63    0.111D 00       64    0 111D 00       65    0 110D 00
   66    0.104D 00       67    0 000D 00       68    0.998D-02       69    0 358D-01       70    0.587D-01
   71    0.781D-01       72    0.944D-01       73    0.104D 00       74    0 111D 00       75    0 111D 00
   76    0.110D 00       77    0.104D 00       78    0.100D 01       79    0 861D 00       80    0.837D 00
   81    0.815D 00       82    0 789D 00       83    0.766D 00       84    0.741D 00       85    0 719D 00
   86    0.705D 00       87    0.678D 00       88    0.654D 00       89    0 100D 01       90    0.833D 00
   91    0.706D 00       92    0.645D 00       93    0.539D 00       94    0.490D 00       95    0 425D 00
   96    0.371D 00       97    0.326D 00       98    0.269D 00       99    0.230D 00      100    0.100D 01
  101    0.782D 00      102    0.680D 00      103    0.592D 00      104    0 519D 00      105    0 449D 00
  106    0.391D 00      107    0.342D 00      108    0.301D 00      109    0 271D 00      110    0 224D 00
  111    0 100D 01      112    0.861D 00      113    0.837D 00      114    0 815D 00      115    0.789D 00
  116    0.766D 00      117    0.741D 00      118    0.719D 00      119    0 705D 00      120    0 678D 00
  121    0 654D 00      122    0.000D 00      123    0.998D-02      124    0 358D-01      125    0 587D-01
  126    0.781D-01      127    0.944D-01      128    0.104D 00      129    0.111D 00      130    0 111D 00
  131    0.110D 00      132    0.104D 00
```

```
                                   CONC DISTRIBUTION AT TIME =  50 000 DAYS
NODES     CONCS      NODES      CONCS     NODES      CONCS     NODES      CONCS     NODES      CONCS

    1     0 0000 00      2     0.189D-01      3     0 452D-01      4     0 720D-01      5     0 959D-01
    6     0 115D 00      7     0.129D 00      8     0 139D 00      9     0 145D 00     10     0 145D 00
   11     0 139D 00     12     0.1000 01     13     0.876D 00     14     0 855D 00     15     0 837D 00
   16     0 813D 00     17     0 795D 00     18     0 772D 00     19     0 755D 00     20     0 742D 00
   21     0 718D 00     22     0.704D 00     23     0.100D 01     24     0 854D 00     25     0 758D 00
   26     0.666D 00     27     0.583D 00     28     0 512D 00     29     0 452D 00     30     0 399D 00
   31     0.352D 00     32     0.311D 00     33     0 274D 00     34     0 1000 01     35     0 796D 00
   36     0 699D 00     37     0.613D 00     38     0 538D 00     39     0 477D 00     40     0 423D 00
   41     0.378D 00     42     0.3400 00     43     0 301D 00     44     0 266D 00     45     0.1000 01
   46     0 876D 00     47     0 855D 00     48     0.837D 00     49     0 813D 00     50     0 795D 00
   51     0.772D 00     52     0.755D 00     53     0 742D 00     54     0 718D 00     55     0 704D 00
   56     0 0000 00     57     0.189D-01     58     0 452D-01     59     0.720D-01     60     0.958D-01
   61     0.115D 00     62     0.129D 00     63     0.139D 00     64     0.145D 00     65     0 145D 00
   66     0.139D 00     67     0.0000 00     68     0.189D-01     69     0 452D-01     70     0 720D-01
   71     0 959D-01     72     0.115D 00     73     0.129D 00     74     0 139D 00     75     0 145D 00
   76     0 145D 00     77     0.139D 00     78     0.1000 01     79     0.876D 00     80     0 855D 00
   81     0.837D 00     82     0.813D 00     83     0.795D 00     84     0.772D 00     85     0 755D 00
   86     0 742D 00     87     0.718D 00     88     0 704D 00     89     0 1000 01     90     0 854D 00
   91     0 758D 00     92     0.666D 00     93     0.583D 00     94     0.512D 00     95     0 452D 00
   96     0.399D 00     97     0.352D 00     98     0 311D 00     99     0.274D 00    100     0 1000 01
  101     0.796D 00    102     0.699D 00    103     0.613D 00    104     0.538D 00    105     0 477D 00
  106     0 423D 00    107     0.378D 00    108     0.3400 00    109     0 301D 00    110     0 266D 00
  111     0 1000 01    112     0.876D 00    113     0.855D 00    114     0 837D 00    115     0 813D 00
  116     0 795D 00    117     0 7720 00    118     0.755D 00    119     0 742D 00    120     0 718D 00
  121     0 704D 00    122     0.0000 00    123     0.189D-01    124     0 452D-01    125     0 720D-01
  126     0.958D-01    127     0.115D 00    128     0 129D 00    129     0.139D 00    130     0 145D 00
  131     0 145D 00    132     0.139D 00
```

70 Elements

```
                    INPUT DATA FOR THREE-DIMENSIONAL
                    ---------------------- -    --- -
                GROUNDWATER DISP BY FINITE ELEMENT METHOD
                -----------------------------------------

TOTAL NO  OF ELEMENTS             =  70
TOTAL NO. OF NODES                = 176
MAXIMUM NO. OF NODES PER ELEMENT  =   8
TOTAL NO. OF MATERIALS            =   1
NUMBER OF PUMPING WELLS           =   0
NUMBER OF CONCS TO BE ESTIMATED   = 168



NUMBER OF PUMPING PERIODS         =    0
TOTAL SIMULATION PERIODS          =    5
FACTOR MULTIPLYING COMPUTED CONCS =    1 00000



STEP SIZE                         =   10 00000
STATE OF PROBLEM                  =    1
NO  OF SPECIFIED CONDITIONS       =   68
```

```
                                        NODE-ELEMENT RELATIONSHIP

   ELEMS       N1        N2        N3        N4        N5        N6        N7        N8

       1        1        12        13         2        89       100       101        90
       2        2        13        14         3        90       101       102        91
       3        3        14        15         4        91       102       103        92
       4        4        15        16         5        92       103       104        93
       5        5        16        17         6        93       104       105        94
       6        6        17        18         7        94       105       106        95
       7        7        18        19         8        95       106       107        96
       8        8        19        20         9        96       107       108        97
       9        9        20        21        10        97       108       109        98
      10       10        21        22        11        98       109       110        99
      11       12        23        24        13       100       111       112       101
      12       13        24        25        14       101       112       113       102
      13       14        25        26        15       102       113       114       103
      14       15        26        27        16       103       114       115       104
      15       16        27        28        17       104       115       116       105
      16       17        28        29        18       105       116       117       106
      17       18        29        30        19       106       117       118       107
      18       19        30        31        20       107       118       119       108
      19       20        31        32        21       108       119       120       109
      20       21        32        33        22       109       120       121       110
      21       23        34        35        24       111       122       123       112
      22       24        35        36        25       112       123       124       113
      23       25        36        37        26       113       124       125       114
      24       26        37        38        27       114       125       126       115
      25       27        38        39        28       115       126       127       116
      26       28        39        40        29       116       127       128       117
      27       29        40        41        30       117       128       129       118
      28       30        41        42        31       118       129       130       119
      29       31        42        43        32       119       130       131       120
      30       32        43        44        33       120       131       132       121
      31       34        45        46        35       122       133       134       123
      32       35        46        47        36       123       134       135       124
      33       36        47        48        37       124       135       136       125
      34       37        48        49        38       125       136       137       126
      35       38        49        50        39       126       137       138       127
      36       39        50        51        40       127       138       139       128
      37       40        51        52        41       128       139       140       129
      38       41        52        53        42       129       140       141       130
      39       42        53        54        43       130       141       142       131
      40       43        54        55        44       131       142       143       132
      41       45        56        57        46       133       144       145       134
      42       46        57        58        47       134       145       146       135
      43       47        58        59        48       135       146       147       136
      44       48        59        60        49       136       147       148       137
      45       49        60        61        50       137       118       119       138
      46       50        61        62        51       138       149       150       139
```

47	51	62	63	52	139	150	151	140
48	52	63	64	53	140	151	152	141
49	53	64	65	54	141	152	153	142
50	54	65	66	55	142	153	154	143
51	56	67	68	57	144	155	156	145
52	57	68	69	58	145	156	157	146
53	58	69	70	59	146	157	158	147
54	59	70	71	60	147	158	159	148
55	60	71	72	61	148	159	160	149
56	61	72	73	62	149	160	161	150
57	62	73	74	63	150	161	162	151
58	63	74	75	64	151	162	163	152
59	64	75	76	65	152	163	164	153
60	65	76	77	66	153	164	165	154
61	67	78	79	68	155	166	167	156
62	68	79	80	69	156	167	168	157
63	69	80	81	70	157	168	169	158
64	70	81	82	71	158	169	170	159
65	71	82	83	72	159	170	171	160
66	72	83	84	73	160	171	172	161
67	73	84	85	74	161	172	173	162
68	74	85	86	75	162	173	174	163
69	75	86	87	76	163	174	175	164
70	76	87	88	77	164	175	176	165

```
                                     FIXED BOUNDARY CONDITIONS

  NODE       ID        NODE       ID        NODE       ID        NODE       ID        NODE       ID

     1        0           2        0           3        0           4        0           5        0
     6        0           7        0           8        0           9        0          10        0
    11        0          12        0          22        0          23        1          33        0
    34        1          44        0          45        1          55        0          56        1
    66        0          67        1          77        0          78        1          88        0
    89        1          99        0         100        0         110        0         111        0
   112        0         113        0         114        0         115        0         116        0
   117        0         118        0         119        0         120        0         121        0
   122        0         123        0         124        0         125        0         126        0
   127        0         128        0         129        0         130        0         131        0
   132        0         133        0         143        0         144        1         154        0
   155        1         165        0         166        1         176        0         177        1
   187        0         188        1         198        0         199        1         209        0
   210        1         220        0         221        0         231        0         232        0
   233        0         234        0         235        0         236        0         237        0
   238        0         239        0         240        0         241        0         242        0


                              MAXIMUM BANDWIDTH = 176 ON ROW NO
```

```
                         OUTPUT FOR THREE-DIMENSIONAL
                         ----------------------------
                    GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                    ------------------------------------------

                   INITIAL CONC DISTRIBUTION AT TIME =   0.000  DAYS

NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

    1   0.0000D 00       2   0.0000D 00       3   0.0000D 00       4   0.0000D 00       5   0.0000D 00
    6   0.0000D 00       7   0.0000D 00       8   0.0000D 00       9   0.0000D 00      10   0.0000D 00
   11   0.0000D 00      12   0.0000D 00      13   0.0000D 00      14   0.0000D 00      15   0.0000D 00
   16   0.0000D 00      17   0.0000D 00      18   0.0000D 00      19   0.0000D 00      20   0.0000D 00
   21   0.0000D 00      22   0.0000D 00      23   0.0000D 00      24   0.0000D 00      25   0.0000D 00
   26   0.0000D 00      27   0.0000D 00      28   0.0000D 00      29   0.0000D 00      30   0.0000D 00
   31   0.0000D 00      32   0.0000D 00      33   0.0000D 00      34   0.0000D 00      35   0.0000D 00
   36   0.0000D 00      37   0.0000D 00      38   0.0000D 00      39   0.0000D 00      40   0.0000D 00
   41   0.0000D 00      42   0.0000D 00      43   0.0000D 00      44   0.0000D 00      45   0.0000D 00
   46   0.0000D 00      47   0.0000D 00      48   0.0000D 00      49   0.0000D 00      50   0.0000D 00
   51   0.0000D 00      52   0.0000D 00      53   0.0000D 00      54   0.0000D 00      55   0.0000D 00
   56   0.0000D 00      57   0.0000D 00      58   0.0000D 00      59   0.0000D 00      60   0.0000D 00
   61   0.0000D 00      62   0.0000D 00      63   0.0000D 00      64   0.0000D 00      65   0.0000D 00
   66   0.0000D 00      67   0.0000D 00      68   0.0000D 00      69   0.0000D 00      70   0.0000D 00
   71   0.0000D 00      72   0.0000D 00      73   0.0000D 00      74   0.0000D 00      75   0.0000D 00
   76   0.0000D 00      77   0.0000D 00      78   0.0000D 00      79   0.0000D 00      80   0.0000D 00
   81   0.0000D 00      82   0.0000D 00      83   0.0000D 00      84   0.0000D 00      85   0.0000D 00
   86   0.0000D 00      87   0.0000D 00      88   0.0000D 00      89   0.0000D 00      90   0.0000D 00
   91   0.0000D 00      92   0.0000D 00      93   0.0000D 00      94   0.0000D 00      95   0.0000D 00
   96   0.0000D 00      97   0.0000D 00      98   0.0000D 00      99   0.0000D 00     100   0.0000D 00
  101   0.0000D 00     102   0.0000D 00     103   0.0000D 00     104   0.0000D 00     105   0.0000D 00
  106   0.0000D 00     107   0.0000D 00     108   0.0000D 00     109   0.0000D 00     110   0.0000D 00
  111   0.0000D 00     112   0.0000D 00     113   0.0000D 00     114   0.0000D 00     115   0.0000D 00
  116   0.0000D 00     117   0.0000D 00     118   0.0000D 00     119   0.0000D 00     120   0.0000D 00
  121   0.0000D 00     122   0.0000D 00     123   0.0000D 00     124   0.0000D 00     125   0.0000D 00
  126   0.0000D 00     127   0.0000D 00     128   0.0000D 00     129   0.0000D 00     130   0.0000D 00
  131   0.0000D 00     132   0.0000D 00     133   0.0000D 00     134   0.0000D 00     135   0.0000D 00
  136   0.0000D 00     137   0.0000D 00     138   0.0000D 00     139   0.0000D 00     140   0.0000D 00
  141   0.0000D 00     142   0.0000D 00     143   0.0000D 00     144   0.0000D 00     145   0.0000D 00
  146   0.0000D 00     147   0.0000D 00     148   0.0000D 00     149   0.0000D 00     150   0.0000D 00
  151   0.0000D 00     152   0.0000D 00     153   0.0000D 00     154   0.0000D 00     155   0.0000D 00
  156   0.0000D 00     157   0.0000D 00     158   0.0000D 00     159   0.0000D 00     160   0.0000D 00
  161   0.0000D 00     162   0.0000D 00     163   0.0000D 00     164   0.0000D 00     165   0.0000D 00
  166   0.0000D 00     167   0.0000D 00     168   0.0000D 00     169   0.0000D 00     170   0.0000D 00
  171   0.0000D 00     172   0.0000D 00     173   0.0000D 00     174   0.0000D 00     175   0.0000D 00
  176   0.0000D 00     177   0.0000D 00     178   0.0000D 00     179   0.0000D 00     180   0.0000D 00
  181   0.0000D 00     182   0.0000D 00     183   0.0000D 00     184   0.0000D 00     185   0.0000D 00
  186   0.0000D 00     187   0.0000D 00     188   0.0000D 00     189   0.0000D 00     190   0.0000D 00
  191   0.0000D 00     192   0.0000D 00     193   0.0000D 00     194   0.0000D 00     195   0.0000D 00
  196   0.0000D 00     197   0.0000D 00     198   0.0000D 00     199   0.0000D 00     200   0.0000D 00
  201   0.0000D 00     202   0.0000D 00     203   0.0000D 00     204   0.0000D 00     205   0.0000D 00
  206   0.0000D 00     207   0.0000D 00     208   0.0000D 00     209   0.0000D 00     210   0.0000D 00
  211   0.0000D 00     212   0.0000D 00     213   0.0000D 00     214   0.0000D 00     215   0.0000D 00


  216   0.0000D 00     217   0.0000D 00     218   0.0000D 00     219   0.0000D 00     220   0.0000D 00
  221   0.0000D 00     222   0.0000D 00     223   0.0000D 00     224   0.0000D 00     225   0.0000D 00
  226   0.0000D 00     227   0.0000D 00     228   0.0000D 00     229   0.0000D 00     230   0.0000D 00
  231   0.0000D 00     232   0.0000D 00     233   0.0000D 00     234   0.0000D 00     235   0.0000D 00
  236   0.0000D 00     237   0.0000D 00     238   0.0000D 00     239   0.0000D 00     240   0.0000D 00
  241   0.0000D 00     242   0.0000D 00
```

```
                              CONC DISTRIBUTION AT TIME =  10 000  DAYS
NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS

    1  0 000D 00      2  0 000D 00      3  0.000D 00      4  0 400D-02      5  0 600D-02
    6  0 700D-02      7  0 600D-02      8  0.400D-02      9  0 200D-02     10  0 100D-02
   11  0 000D 00     12  0 000D 00     13  0.240D-01     14  0 420D-01     15  0.490D-01
   16  0 470D-01     17  0 410D-01     18  0.320D-01     19  0.240D-01     20  0 170D-01
   21  0 120D-01     22  0.800D-02     23  0.100D 01     24  0.857D 00     25  0.816D 00
   26  0 715D 00     27  0 661D 00     28  0 614D 00     29  0.573D 00     30  0 549D 00
   31  0 535D 00     32  0 520D 00     33  0.511D 00     34  0.100D 01     35  0 685D 00
   36  0 500D 00     37  0.362D 00     38  0.261D 00     39  0 182D 00     40  0.121D 00
   41  0 780D-01     42  0 480D-01     43  0.280D-01     44  0 160D-01     45  0 100D 01
   46  0 753D 00     47  0 582D 00     48  0.431D 00     49  0 312D 00     50  0 217D 00
   51  0 143D 00     52  0.910D-01     53  0.560D-01     54  0 320D-01     55  0 170D-01
   56  0 100D 01     57  0.767D 00     58  0.604D 00     59  0 452D 00     60  0.329D 00
   61  0 229D 00     62  0.153D 00     63  0.970D-01     64  0 600D-01     65  0.350D-01
   66  0 190D-01     67  0 100D 01     68  0.753D 00     69  0.582D 00     70  0 431D 00
   71  0 312D 00     72  0.217D 00     73  0.143D 00     74  0.910D-01     75  0 560D-01
   76  0.320D-01     77  0 170D-01     78  0.100D 01     79  0 685D 00     80  0.500D 00
   81  0.362D 00     82  0.261D 00     83  0.182D 00     84  0.121D 00     85  0 780D-01
   86  0 480D-01     87  0.280D-01     88  0.160D-01     89  0.100D 01     90  0.857D 00
   91  0 816D 00     92  0 715D 00     93  0.661D 00     94  0 614D 00     95  0.573D 00
   96  0 549D 00     97  0.535D 00     98  0.520D 00     99  0 511D 00    100  0.000D 00
  101  0.240D-01    102  0 420D-01    103  0 490D-01    104  0 470D-01    105  0.410D-01
  106  0 320D-01    107  0 240D-01    108  0.170D-01    109  0.120D-01    110  0 800D-02
  111  0 000D 00    112  0 000D 00    113  0 000D 00    114  0 400D-02    115  0.600D-02
  116  0 700D-02    117  0.600D-02    118  0.400D-02    119  0.200D-02    120  0.100D-02
  121  0 000D 00    122  0 000D 00    123  0.000D 00    124  0 00CD 00    125  0 400D-02
  126  0 600D-02    127  0.700D-02    128  0.600D-02    129  0 400D-02    130  0.200D-02
  131  0 100D-02    132  0.000D 00    133  0.000D 00    134  0.240D-01    135  0 420D-01
  136  0 490D-01    137  0 470D-01    138  0.410D-01    139  0.320D-01    140  0.240D-01
  141  0 170D-01    142  0.120D-01    143  0.800D-02    144  0 100D 01    145  0.857D 00
  146  0 816D 00    147  0.715D 00    148  0 661D 00    149  0 614D 00    150  0.573D 00
  151  0 549D 00    152  0.535D 00    153  0.520D 00    154  0 511D 00    155  0.100D 01
  156  0 685D 00    157  0.500D 00    158  0.362D 00    159  0.261D 00    160  0 182D 00
  161  0 121D 00    162  0 780D-01    163  0 480D-01    164  0 280D-01    165  0 160D-01
  166  0 100D 01    167  0.753D 00    168  0 582D 00    169  0 431D 00    170  0 312D 00
  171  0 217D 00    172  0 143D 00    173  0.910D-01    174  0 560D-01    175  0.320D-01
  176  0 170D-01    177  0 100D 01    178  0.767D 00    179  0 604D 00    180  0 452D 00
  181  0 329D 00    182  0 229D 00    183  0.153D 00    184  0 970D-01    185  0 600D-01
  186  0 350D-01    187  0 190D-01    188  0 100D 01    189  0 753D 00    190  0.582D 00
  191  0 431D 00    192  0 312D 00    193  0 217D 00    194  0 143D 00    195  0 910D-01
  196  0 560D-01    197  0 320D-01    198  0 170D-01    199  0 100D 01    200  0 685D 00
  201  0 500D 00    202  0 362D 00    203  0 261D 00    204  0 182D 00    205  0 121D 00
  206  0 780D-01    207  0 480D-01    208  0 280D-01    209  0 160D-01    210  0.100D 01
  211  0 857D 00    212  0 816D 00    213  0 715D 00    214  0 661D 00    215  0 614D 00
  216  0 573D 00    217  0 549D 00    218  0.535D 00    219  0 520D 00    220  0 511D 00
  221  0 000D 00    222  0 240D-01    223  0 420D-01    224  0 490D-01    225  0 470D-01
  226  0 410D-01    227  0 320D-01    228  0 240D-01    229  0 170D 01    230  0 120D-01
  231  0 800D-02    232  0 000D 00    233  0.000D 00    234  0 000D 00    235  0 400D-02
  236  0 600D-02    237  0 700D-02    238  0.600D-02    239  0 400D-02    240  0.200D-02
  241  0 100D-02    242  0.000D 00
```

```
                              CONC DISTRIBUTION AT TIME =  20 000  DAYS
NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS
   1   0.0000 00      2   0.2000-02      3   0.1330-01      4   0.2400-01      5   0.3300-01
   6   0.3900-01      7   0.4000-01      8   0.3900-01      9   0.3600-01     10   0.3000-01
  11   0.2500-01     12   0.0000 00     13   0.3800-01     14   0.7000-01     15   0.8800-01
  16   0.9600-01     17   0.9400-01     18   0.8700-01     19   0.7700-01     20   0.6700-01
  21   0.5500-01     22   0.4400-01     23   0.0000 00     24   0.3800-01     25   0.7000-01
  26   0.8800-01     27   0.9600-01     28   0.9400-01     29   0.8700-01     30   0.7700-01
  31   0.6700-01     32   0.5500-01     33   0.4400-01     34   0.1000 01     35   0.8930 00
  36   0.8490 00     37   0.8000 00     38   0.7590 00     39   0.7190 00     40   0.6780 00
  41   0.6470 00     42   0.6240 00     43   0.5950 00     44   0.5720 00     45   0.1000 01
  46   0.7290 00     47   0.5770 00     48   0.4660 00     49   0.3820 00     50   0.3100 00
  51   0.2490 00     52   0.1980 00     53   0.1560 00     54   0.1190 00     55   0.8800-01
  56   0.1000 01     57   0.8050 00     58   0.6900 00     59   0.5500 00     60   0.4500 00
  61   0.3630 00     62   0.3050 00     63   0.2370 00     64   0.1870 00     65   0.1390 00
  66   0.1050 00     67   0.1000 01     68   0.8210 00     69   0.6970 00     70   0.5770 00
  71   0.4740 00     72   0.3830 00     73   0.3030 00     74   0.2380 00     75   0.1860 00
  76   0.1400 00     77   0.1040 00     78   0.1000 01     79   0.8050 00     80   0.6900 00
  81   0.5500 00     82   0.4500 00     83   0.3630 00     84   0.3050 00     85   0.2370 00
  86   0.1870 00     87   0.1390 00     88   0.1050 00     89   0.1000 01     90   0.7290 00
  91   0.5770 00     92   0.4660 00     93   0.3820 00     94   0.3100 00     95   0.2490 00
  96   0.1980 00     97   0.1560 00     98   0.1190 00     99   0.8800-01    100   0.1000 01
 101   0.8930 00    102   0.8490 00    103   0.8000 00    104   0.7590 00    105   0.7190 00
 106   0.6780 00    107   0.6470 00    108   0.6240 00    109   0.5950 00    110   0.5720 00
 111   0.0000 00    112   0.2000-02    113   0.1330-01    114   0.2400-01    115   0.3300-01
 116   0.3900-01    117   0.4000-01    118   0.3900-01    119   0.3600-01    120   0.3000-01
 121   0.2500-01    122   0.0000 00    123   0.2000-02    124   0.1330-01    125   0.2400-01
 126   0.3300-01    127   0.3900-01    128   0.4000-01    129   0.3900-01    130   0.3600-01
 131   0.3000-01    132   0.2500-01    133   0.0000 00    134   0.3800-01    135   0.7000-01
 136   0.8800-01    137   0.9600-01    138   0.9400-01    139   0.8700-01    140   0.7700-01
 141   0.6700-01    142   0.5500-01    143   0.4400-01    144   0.0000 00    145   0.3800-01
 146   0.7000-01    147   0.8800-01    148   0.9600-01    149   0.9400-01    150   0.8700-01
 151   0.7700-01    152   0.6700-01    153   0.5500-01    154   0.4400-01    155   0.1000 01
 156   0.8930 00    157   0.8490 00    158   0.8000 00    159   0.7590 00    160   0.7190 00
 161   0.6780 00    162   0.6470 00    163   0.6240 00    164   0.5950 00    165   0.5720 00
 166   0.1000 01    167   0.7290 00    168   0.5770 00    169   0.4660 00    170   0.3820 00
 171   0.3100 00    172   0.2490 00    173   0.1980 00    174   0.1560 00    175   0.1190 00
 176   0.8800-01    177   0.1000 01    178   0.8050 00    179   0.6900 00    180   0.5500 00
 181   0.4500 00    182   0.3630 00    183   0.3050 00    184   0.2270 00    185   0.1870 00
 186   0.1330 00    187   0.1050 00    188   0.1000 01    189   0.8210 00    190   0.6900 00
 191   0.5770 00    192   0.4740 00    193   0.3830 00    194   0.3030 00    195   0.2380 00
 196   0.1860 00    197   0.1400 00    198   0.1040 00    199   0.1000 01    200   0.8050 00
 201   0.6900 00    202   0.5500 00    203   0.4500 00    204   0.3630 00    205   0.3050 00
 206   0.2270 00    207   0.1870 00    208   0.1330 00    209   0.1050 00    210   0.1000 01
 211   0.7290 00    212   0.5770 00    213   0.4660 00    214   0.3820 00    215   0.3100 00
 216   0.2490 00    217   0.1980 00    218   0.1560 00    219   0.1190 00    220   0.8800-01
 221   0.1000 01    222   0.8930 00    223   0.8490 00    224   0.8000 00    225   0.7590 00
 226   0.7190 00    227   0.6780 00    228   0.6470 00    229   0.6240 00    230   0.5950 00
 231   0.5720 00    232   0.0000 00    233   0.2000-02    234   0.1330-01    235   0.2400-01
 236   0.3300-01    237   0.3900-01    238   0.4000-01    239   0.3900-01    240   0.3600-01
 241   0.3000-01    242   0.2500-01
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                                   CONC DISTRIBUTION AT TIME =  30 000  DAYS
 NODES     CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

     1    0 000D 00       2    0.900D-02       3    0.270D-01       4    0 450D-01       5    0 610D-01
     6    0 720D-01       7    0.780D-01       8    0.800D-01       9    0 790D-01      10    0 740D-01
    11    0 660D-01      12    0.000D 00      13    0.470D-01      14    0.870D-01      15    0.114D 00
    16    0 130D 00      17    0 135D-01      18    0.133D 00      19    0 126D 00      20    0 118D 00
    21    0 106D 00      22    0.930D-01      23    0.100D 01      24    0.815D 00      25    0 880D 00
    26    0 843D 00      27    0.811D 00      28    0.778D 00      29    0 744D 00      30    0 717D 00
    31    0 693D 00      32    0 663D 00      33    0.636D 00      34    0 100D 01      35    0.751D 00
    36    0 612D 00      37    0.513D 00      38    0 440D 00      39    0 378D 00      40    0.321D 00
    41    0 275D 00      42    0 234D 00      43    0 195D 00      44    0 161D 00      45    0 100D 01
    46    0 828D 00      47    0 710D 00      48    0.602D 00      49    0 514D 00      50    0 436D 00
    51    0 367D 00      52    0.310D 00      53    0.261D 00      54    0 215D 00      55    0 176D 00
    56    0.100D 01      57    0.845D 00      58    0.737D 00      59    0.631D 00      60    0 539D 00
    61    0 458D 00      62    0.385D 00      63    0.325D 00      64    0.272D 00      65    0.224D 00
    66    0 183D 00      67    0 100D 01      68    0.828D 00      69    0.710D 00      70    0 602D 00
    71    0 514D 00      72    0.436D 00      73    0.367D 00      74    0.310D 00      75    0.261D 00
    76    0.215D 00      77    0 176D 00      78    0.100D 01      79    0 751D 00      80    0 612D 00
    81    0.513D 00      82    0.440D 00      83    0.378D 00      84    0.321D 00      85    0.275D 00
    86    0 234D 00      87    0.195D 00      88    0.161D 00      89    0 100D 01      90    0.915D 00
    91    0 880D 00      92    0.843D 00      93    0.811D 00      94    0.778D 00      95    0 744D 00
    96    0 717D 00      97    0 693D 00      98    0 663D 00      99    0 636D 00     100    0 000D 00
   101    0 470D-01     102    0.870D-01     103    0.114D 00     104    0 130D 00     105    0 135D-01
   106    0.133D 00     107    0.126D 00     108    0.118D 00     109    0.106D 00     110    0.930D-01
   111    0 000D 00     112    0.900D-02     113    0 270D-01     114    0 450D-01     115    0 610D-01
   116    0 720D-01     117    0.780D-01     118    0.800D-01     119    0.790D-01     120    0 740D-01
   121    0 660D-01     122    0.000D 00     123    0.900D-02     124    0 270D-01     125    0 450D-01
   126    0.610D-01     127    0.720D-01     128    0.780D-01     129    0 800D-01     130    0 790D-01
   131    0.740D-01     132    0.660D-01     133    0.000D 00     134    0 470D-01     135    0.870D-01
   136    0.114D 00     137    0.130D 00     138    0.135D-01     139    0 133D 00     140    0.126D 00
   141    0 118D 00     142    0 106D 00     143    0.930D-01     144    0 100D 01     145    0 915D 00
   146    0 880D 00     147    0.843D 00     148    0.811D 00     149    0.778D 00     150    0.744D 00
   151    0 717D 00     152    0.693D 00     153    0.663D 00     154    0 636D 00     155    0.100D 01
   156    0 751D 00     157    0 612D 00     158    0.513D 00     159    0 440D 00     160    0.378D 00
   161    0.321D 00     162    0.275D 00     163    0.234D 00     164    0.195D 00     165    0 161D 00
   166    0 100D 01     167    0.828D 00     168    0.710D 00     169    0.602D 00     170    0 514D 00
   171    0 436D 00     172    0 367D 00     173    0.310D 00     174    0.261D 00     175    0 215D 00
   176    0 176D 00     177    0.100D 01     178    0 845D 00     179    0.737D 00     180    0 631D 00
   181    0 539D 00     182    0 458D 00     183    0 385D 00     184    0 325D 00     185    0 272D 00
   186    0 224D 00     187    0.183D 00     188    0.100D 01     189    0 828D 00     190    0.710D 00
   191    0 602D 00     192    0 514D 00     193    0 436D 00     194    0 367D 00     195    0.310D 00
   196    0 261D 00     197    0.215D 00     198    0 176D 00     199    0 100D 01     200    0 751D 00
   201    0 612D 00     202    0 513D 00     203    0 440D 00     204    0 378D 00     205    0 321D 00
   206    0 275D 00     207    0 234D 00     208    0 195D 00     209    0 161D 00     210    0 100D 01
   211    0 915D 00     212    0 880D 00     213    0.843D 00     214    0 811D 00     215    0 778D 00
   216    0 744D 00     217    0 717D 00     218    0.693D 00     219    0 663D 00     220    0 636D 00
   221    0 000D 00     222    0 470D-01     223    0.870D-01     224    0 114D 00     225    0 130D 00
   226    0 135D-01     227    0.133D 00     228    0.126D 00     229    0 118D 00     230    0 106D 00
   231    0 930D-01     232    0.000D 00     233    0 900D-02     234    0 270D-01     235    0 450D-01
   236    0 610D-01     237    0.720D-01     238    0.780D-01     239    0 800D-01     240    0.790D-01
   241    0 740D-01     242    0 660D-01
```

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                              CONC DISTRIBUTION AT TIME =  40.000 DAYS
NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS

   1   0.000D 00       2   0.150D-01       3   0.390D-01       4   0.630D-01       5   0.840D-01
   6   0.101D 00       7   0.111D 00       8   0.118D 00       9   0.119D 00      10   0.116D 00
  11   0.110D 00      12   0.000D 00      13   0.540D-01      14   0.101D 00      15   0.134D 00
  16   0.156D 00      17   0.166D 00      18   0.168D 00      19   0.167D 00      20   0.162D 00
  21   0.152D 00      22   0.140D 00      23   0.100D 01      24   0.929D 00      25   0.902D 00
  26   0.872D 00      27   0.846D 00      28   0.817D 00      29   0.789D 00      30   0.765D 00
  31   0.744D 00      32   0.716D 00      33   0.690D 00      34   0.100D 01      35   0.765D 00
  36   0.633D 00      37   0.542D 00      38   0.475D 00      39   0.418D 00      40   0.368D 00
  41   0.326D 00      42   0.289D 00      43   0.252D 00      44   0.218D 00      45   0.100D 01
  46   0.844D 00      47   0.732D 00      48   0.633D 00      49   0.551D 00      50   0.479D 00
  51   0.416D 00      52   0.364D 00      53   0.318D 00      54   0.274D 00      55   0.236D 00
  56   0.100D 01      57   0.861D 00      58   0.760D 00      59   0.662D 00      60   0.577D 00
  61   0.502D 00      62   0.434D 00      63   0.379D 00      64   0.330D 00      65   0.284D 00
  66   0.243D 00      67   0.100D 01      68   0.844D 00      69   0.732D 00      70   0.633D 00
  71   0.551D 00      72   0.479D 00      73   0.416D 00      74   0.364D 00      75   0.318D 00
  76   0.274D 00      77   0.236D 00      78   0.100D 01      79   0.765D 00      80   0.633D 00
  81   0.542D 00      82   0.475D 00      83   0.418D 00      84   0.368D 00      85   0.326D 00
  86   0.289D 00      87   0.252D 00      88   0.218D 00      89   0.100D 01      90   0.929D 00
  91   0.902D 00      92   0.872D 00      93   0.846D 00      94   0.817D 00      95   0.789D 00
  96   0.765D 00      97   0.744D 00      98   0.716D 00      99   0.690D 00     100   0.000D 00
 101   0.540D-01     102   0.101D 00     103   0.134D 00     104   0.156D 00     105   0.166D 00
 106   0.168D 00     107   0.167D 00     108   0.162D 00     109   0.152D 00     110   0.140D 00
 111   0.000D 00     112   0.150D-01     113   0.390D-01     114   0.630D-01     115   0.840D-01
 116   0.101D 00     117   0.111D 00     118   0.118D 00     119   0.119D 00     120   0.116D 00
 121   0.110D 00     122   0.000D 00     123   0.150D-01     124   0.390D-01     125   0.630D-01
 126   0.840D-01     127   0.101D 00     128   0.111D 00     129   0.118D 00     130   0.119D 00
 131   0.116D 00     132   0.110D 00     133   0.000D 00     134   0.540D-01     135   0.101D 00
 136   0.134D 00     137   0.156D 00     138   0.166D 00     139   0.168D 00     140   0.167D 00
 141   0.162D 00     142   0.152D 00     143   0.140D 00     144   0.100D 01     145   0.929D 00
 146   0.902D 00     147   0.872D 00     148   0.846D 00     149   0.817D 00     150   0.789D 00
 151   0.765D 00     152   0.744D 00     153   0.716D 00     154   0.690D 00     155   0.100D 01
 156   0.765D 00     157   0.633D 00     158   0.542D 00     159   0.475D 00     160   0.418D 00
 161   0.368D 00     162   0.326D 00     163   0.289D 00     164   0.252D 00     165   0.218D 00
 166   0.100D 01     167   0.844D 00     168   0.732D 00     169   0.633D 00     170   0.551D 00
 171   0.479D 00     172   0.416D 00     173   0.364D 00     174   0.318D 00     175   0.274D 00
 176   0.236D 00     177   0.100D 01     178   0.861D 00     179   0.760D 00     180   0.662D 00
 181   0.577D 00     182   0.502D 00     183   0.434D 00     184   0.379D 00     185   0.330D 00
 186   0.284D 00     187   0.243D 00     188   0.100D 01     189   0.844D 00     190   0.732D 00
 191   0.633D 00     192   0.551D 00     193   0.479D 00     194   0.416D 00     195   0.364D 00
 196   0.318D 00     197   0.274D 00     198   0.236D 00     199   0.100D 01     200   0.765D 00
 201   0.633D 00     202   0.542D 00     203   0.475D 00     204   0.418D 00     205   0.368D 00
 206   0.326D 00     207   0.289D 00     208   0.252D 00     209   0.218D 00     210   0.100D 01
 211   0.929D 00     212   0.902D 00     213   0.872D 00     214   0.846D 00     215   0.817D 00
 216   0.789D 00     217   0.765D 00     218   0.744D 00     219   0.716D 00     220   0.690D 00
 221   0.000D 00     222   0.540D-01     223   0.101D 00     224   0.134D 00     225   0.156D 00
 226   0.166D 00     227   0.168D 00     228   0.167D 00     229   0.162D 00     230   0.152D 00
 231   0.140D 00     232   0.000D 00     233   0.150D-01     234   0.390D-01     235   0.630D-01
 236   0.840D-01     237   0.101D 00     238   0.111D 00     239   0.118D 00     240   0.119D 00
 241   0.116D 00     242   0.110D 00
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                     COORDINATES AND INITIAL CONCS OF NODES (L)

NODES      Y(I)          X(I)          Z(I)          CINI(I)

   1    0.000 00      0.000 00      0.100 03      0.000 00
   2    0.100 02      0.000 00      0.100 03      0.000 00
   3    0.200 02      0.000 00      0.100 03      0.000 00
   4    0.300 02      0.000 00      0.100 03      0.000 00
   5    0.400 02      0.000 00      0.100 03      0.000 00
   6    0.500 02      0.000 00      0.100 03      0.000 00
   7    0.600 02      0.000 00      0.100 03      0.000 00
   8    0.700 02      0.000 00      0.100 03      0.000 00
   9    0.800 02      0.000 00      0.100 03      0.000 00
  10    0.900 02      0.000 00      0.100 03      0.000 00
  11    0.100 03      0.000 00      0.100 03      0.000 00
  12    0.000 00      0.100 02      0.100 03      0.000 00
  13    0.100 02      0.100 02      0.100 03      0.000 00
  14    0.200 02      0.100 02      0.100 03      0.000 00
  15    0.300 02      0.100 02      0.100 03      0.000 00
  16    0.400 02      0.100 02      0.100 03      0.000 00
  17    0.500 02      0.100 02      0.100 03      0.000 00
  18    0.600 02      0.100 02      0.100 03      0.000 00
  19    0.700 02      0.100 02      0.100 03      0.000 00
  20    0.800 02      0.100 02      0.100 03      0.000 00
  21    0.900 02      0.100 02      0.100 03      0.000 00
  22    0.100 03      0.100 02      0.100 03      0.000 00
  23    0.000 00      0.200 02      0.100 03      0.100 01
  24    0.100 02      0.200 02      0.100 03      0.000 00
  25    0.200 02      0.200 02      0.100 03      0.000 00
  26    0.300 02      0.200 02      0.100 03      0.000 00
  27    0.400 02      0.200 02      0.100 03      0.000 00
  28    0.500 02      0.200 02      0.100 03      0.000 00
  29    0.600 02      0.200 02      0.100 03      0.000 00
  30    0.700 02      0.200 02      0.100 03      0.000 00
  31    0.800 02      0.200 02      0.100 03      0.000 00
  32    0.900 02      0.200 02      0.100 03      0.000 00
  33    0.100 03      0.200 02      0.100 03      0.000 00
  34    0.000 00      0.300 02      0.100 03      0.100 01
  35    0.100 02      0.300 02      0.100 03      0.000 00
  36    0.200 02      0.300 02      0.100 03      0.000 00
  37    0.300 02      0.300 02      0.100 03      0.000 00
  38    0.400 02      0.300 02      0.100 03      0.000 00
  39    0.500 02      0.300 02      0.100 03      0.000 00
  40    0.600 02      0.300 02      0.100 03      0.000 00
  41    0.700 02      0.300 02      0.100 03      0.000 00
  42    0.800 02      0.300 02      0.100 03      0.000 00
  43    0.900 02      0.300 02      0.100 03      0.000 00
  44    0.100 03      0.300 02      0.100 03      0.000 00
  45    0.000 00      0.350 02      0.100 03      0.100 01
  46    0.100 02      0.350 02      0.100 03      0.000 00
  47    0.200 02      0.350 02      0.100 03      0.000 00
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 48    0.300 02    0.350 02    0.100 03    0.000 00
 49    0.400 02    0.350 02    0.100 03    0.000 00
 50    0.500 02    0.350 02    0.100 03    0.000 00
 51    0.600 02    0.350 02    0.100 03    0.000 00
 52    0.700 02    0.350 02    0.100 03    0.000 00
 53    0.800 02    0.350 02    0.100 03    0.000 00
 54    0.900 02    0.350 02    0.100 03    0.000 00
 55    0.100 03    0.350 02    0.100 03    0.000 00
 56    0.000 00    0.500 02    0.100 03    0.100 01
 57    0.100 02    0.500 02    0.100 03    0.000 00
 58    0.200 02    0.500 02    0.100 03    0.000 00
 59    0.300 02    0.500 02    0.100 03    0.000 00
 60    0.400 02    0.500 02    0.100 03    0.000 00
 61    0.500 02    0.500 02    0.100 03    0.000 00
 62    0.600 02    0.500 02    0.100 03    0.000 00
 63    0.700 02    0.500 02    0.100 03    0.000 00
 64    0.800 02    0.500 02    0.100 03    0.000 00
 65    0.900 02    0.500 02    0.100 03    0.000 00
 66    0.100 03    0.500 02    0.100 03    0.000 00
 67    0.000 00    0.600 02    0.100 03    0.000 00
 68    0.100 02    0.600 02    0.100 03    0.000 00
 69    0.200 02    0.600 02    0.100 03    0.000 00
 70    0.300 02    0.600 02    0.100 03    0.000 00
 71    0.400 02    0.600 02    0.100 03    0.000 00
 72    0.500 02    0.600 02    0.100 03    0.000 00
 73    0.600 02    0.600 02    0.100 03    0.000 00
 74    0.700 02    0.600 02    0.100 03    0.000 00
 75    0.800 02    0.600 02    0.100 03    0.000 00
 76    0.900 02    0.600 02    0.100 03    0.000 00
 77    0.100 03    0.600 02    0.100 03    0.000 00
 78    0.000 00    0.700 02    0.100 03    0.000 00
 79    0.100 02    0.700 02    0.100 03    0.000 00
 80    0.200 02    0.700 02    0.100 03    0.000 00
 81    0.300 02    0.700 02    0.100 03    0.000 00
 82    0.400 02    0.700 02    0.100 03    0.000 00
 83    0.500 02    0.700 02    0.100 03    0.000 00
 84    0.600 02    0.700 02    0.100 03    0.000 00
 85    0.700 02    0.700 02    0.100 03    0.000 00
 86    0.800 02    0.700 02    0.100 03    0.000 00
 87    0.900 02    0.700 02    0.100 03    0.000 00
 88    0.100 03    0.700 02    0.100 03    0.000 00
 89    0.000 00    0.000 00    0.000 00    0.000 00
 90    0.100 02    0.000 00    0.000 00    0.000 00
 91    0.200 02    0.000 00    0.000 00    0.000 00
 92    0.300 02    0.000 00    0.000 00    0.000 00
 93    0.400 02    0.000 00    0.000 00    0.000 00
 94    0.500 02    0.000 00    0.000 00    0.000 00
 95    0.600 02    0.000 00    0.000 00    0.000 00
 96    0.700 02    0.000 00    0.000 00    0.000 00
 97    0.800 02    0.000 00    0.000 00    0.000 00
 98    0.900 02    0.000 00    0.000 00    0.000 00
 99    0.100 03    0.000 00    0.000 00    0.000 00
100    0.000 00    0.100 02    0.000 00    0.000 00
101    0.100 02    0.100 02    0.000 00    0.000 00
102    0.200 02    0.100 02    0.000 00    0.000 00
103    0.300 02    0.100 02    0.000 00    0.000 00
104    0.400 02    0.100 02    0.000 00    0.000 00
105    0.500 02    0.100 02    0.000 00    0.000 00
106    0.600 02    0.100 02    0.000 00    0.000 00
107    0.700 02    0.100 02    0.000 00    0.000 00
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108    0.800 02    0.100 02    0.000 00    0.000 00
109    0.900 02    0.100 02    0.000 00    0.000 00
110    0.100 03    0.100 02    0.000 00    0.000 00
111    0.000 00    0.200 02    0.000 00    0.100 01
112    0.100 02    0.200 02    0.000 00    0.000 00
113    0.200 02    0.200 02    0.000 00    0.000 00
114    0.300 02    0.200 02    0.000 00    0.000 00
115    0.400 02    0.200 02    0.000 00    0.000 00
116    0.500 02    0.200 02    0.000 00    0.000 00
117    0.600 02    0.200 02    0.000 00    0.000 00
118    0.700 02    0.200 02    0.000 00    0.000 00
119    0.800 02    0.200 02    0.000 00    0.000 00
120    0.900 02    0.200 02    0.000 00    0.000 00
121    0.100 03    0.200 02    0.000 00    0.000 00
122    0.000 00    0.300 02    0.000 00    0.100 01
123    0.100 02    0.300 02    0.000 00    0.000 00
124    0.200 02    0.300 02    0.000 00    0.000 00
125    0.300 02    0.300 02    0.000 00    0.000 00
126    0.400 02    0.300 02    0.000 00    0.000 00
127    0.500 02    0.300 02    0.000 00    0.000 00
128    0.600 02    0.300 02    0.000 00    0.000 00
129    0.700 02    0.300 02    0.000 00    0.000 00
130    0.800 02    0.300 02    0.000 00    0.000 00
131    0.900 02    0.300 02    0.000 00    0.000 00
132    0.100 03    0.300 02    0.000 00    0.000 00
133    0.000 00    0.350 01    0.000 00    0.100 01
134    0.100 02    0.350 02    0.000 00    0.000 00
135    0.200 02    0.350 02    0.000 00    0.000 00
136    0.300 02    0.350 02    0.000 00    0.000 00
137    0.400 02    0.350 02    0.000 00    0.000 00
138    0.500 02    0.350 02    0.000 00    0.000 00
139    0.600 02    0.350 02    0.000 00    0.000 00
140    0.700 02    0.350 02    0.000 00    0.000 00
141    0.800 02    0.350 02    0.000 00    0.000 00
142    0.900 02    0.350 02    0.000 00    0.000 00
143    0.100 03    0.350 02    0.000 00    0.000 00
144    0.000 00    0.500 02    0.000 00    0.100 01
145    0.100 02    0.500 02    0.000 00    0.000 00
146    0.200 02    0.500 02    0.000 00    0.000 00
147    0.300 02    0.500 02    0.000 00    0.000 00
148    0.400 02    0.500 02    0.000 00    0.000 00
149    0.500 02    0.500 02    0.000 00    0.000 00
150    0.600 02    0.500 02    0.000 00    0.000 00
151    0.700 02    0.500 02    0.000 00    0.000 00
152    0.800 02    0.500 02    0.000 00    0.000 00
153    0.900 02    0.500 02    0.000 00    0.000 00
154    0.100 03    0.500 02    0.000 00    0.000 00
155    0.000 00    0.600 02    0.000 00    0.000 00
156    0.100 02    0.600 02    0.000 00    0.000 00
157    0.200 02    0.600 02    0.000 00    0.000 00
158    0.300 02    0.600 02    0.000 00    0.000 00
159    0.400 02    0.600 02    0.000 00    0.000 00
160    0.500 02    0.600 02    0.000 00    0.000 00
161    0.600 02    0.600 02    0.000 00    0.000 00
162    0.700 02    0.600 02    0.000 00    0.000 00
163    0.800 02    0.600 02    0.000 00    0.000 00
164    0.900 02    0.600 02    0.000 00    0.000 00
165    0.100 03    0.600 02    0.000 00    0.000 00
166    0.000 00    0.700 02    0.000 00    0.000 00
167    0.100 02    0.700 02    0.000 00    0.000 00
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        168      0.200 02      0.700 02      0.000 00      0.000 00
        169      0.300 02      0.700 02      0.000 00      0.000 00
        170      0 400 02      0.700 02      0.000 00      0 000 00
        171      0.500 02      0.700 02      0.000 00      0.000 00
        172      0.600 02      0.700 02      0 000 00      0.000 00
        173      0.700 02      0.700 02      0 000 00      0.000 00
        174      0 800 02      0.700 02      0.000 00      0.000 00
        175      0.900 02      0.700 02      0.000 00      0 000 00
        176      0.100 03      0.700 02      0 000 00      0 000 00


                            FIXED BOUNDARY CONDITIONS

   NODE       ID       NODE       ID       NODE       ID       NODE       ID       NOOF       ID

      1        0          2        0          3        0          4        0          5        0
      6        0          7        0          8        0          9        0         10        0
     11        0         12        1         22        0         23        1         33        0
     34        1         44        0         45        1         55        0         56        1
     66        0         67        0         77        0         78        0         79        0
     80        0         81        0         82        0         83        0         84        0
     85        0         86        0         87        0         88        0         89        0
     90        0         91        0         92        0         93        0         94        0
     95        0         96        0         97        0         98        0         99        0
    100        0        110        0        111        1        121        0        122        1
    132        0        133        1        143        0        141        1        151        0
    155        0        165        0        166        0        167        0        168        0
    169        0        170        0        171        0        172        0        173        0
    174        0        175        0        176        0


                    MAXIMUM BANDWIDTH =  101 ON ROW NO.   1
```

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                          OUTPUT FOR THREE-DIMENSIONAL
                          ----------------------------
                   GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                   ------------------------------------------
     .
                  INITIAL CONC DISTRIBUTION AT TIME =   0.000  DAYS
NODES    CONCS     NODES    CONCS     NODES    CONCS     NODES    CONCS     NODES    CONCS

    1  0.0000D 00      2  0.0000D 00      3  0.0000D 00      4  0.0000D 00      5  0.0000D 00
    6  0.0000D 00      7  0.0000D 00      8  0.0000D 00      9  0.0000D 00     10  0.0000D 00
   11  0.0000D 00     12  0.0000D 00     13  0.0000D 00     14  0.0000D 00     15  0.0000D 00
   16  0.0000D 00     17  0.0000D 00     18  0.0000D 00     19  0.0000D 00     20  0.0000D 00
   21  0.0000D 00     22  0.0000D 00     23  0.0000D 00     24  0.0000D 00     25  0.0000D 00
   26  0.0000D 00     27  0.0000D 00     28  0.0000D 00     29  0.0000D 00     30  0.0000D 00
   31  0.0000D 00     32  0.0000D 00     33  0.0000D 00     34  0.0000D 00     35  0.0000D 00
   36  0.0000D 00     37  0.0000D 00     38  0.0000D 00     39  0.0000D 00     40  0.0000D 00
   41  0.0000D 00     42  0.0000D 00     43  0.0000D 00     44  0.0000D 00     45  0.0000D 00
   46  0.0000D 00     47  0.0000D 00     48  0.0000D 00     49  0.0000D 00     50  0.0000D 00
   51  0.0000D 00     52  0.0000D 00     53  0.0000D 00     54  0.0000D 00     55  0.0000D 00
   56  0.0000D 00     57  0.0000D 00     58  0.0000D 00     59  0.0000D 00     60  0.0000D 00
   61  0.0000D 00     62  0.0000D 00     63  0.0000D 00     64  0.0000D 00     65  0.0000D 00
   66  0.0000D 00     67  0.0000D 00     68  0.0000D 00     69  0.0000D 00     70  0.0000D 00
   71  0.0000D 00     72  0.0000D 00     73  0.0000D 00     74  0.0000D 00     75  0.0000D 00
   76  0.0000D 00     77  0.0000D 00     78  0.0000D 00     79  0.0000D 00     80  0.0000D 00
   81  0.0000D 00     82  0.0000D 00     83  0.0000D 00     84  0.0000D 00     85  0.0000D 00
   86  0.0000D 00     87  0.0000D 00     88  0.0000D 00     89  0.0000D 00     90  0.0000D 00
   91  0.0000D 00     92  0.0000D 00     93  0.0000D 00     94  0.0000D 00     95  0.0000D 00
   96  0.0000D 00     97  0.0000D 00     98  0.0000D 00     99  0.0000D 00    100  0.0000D 00
  101  0.0000D 00    102  0.0000D 00    103  0.0000D 00    104  0.0000D 00    105  0.0000D 00
  106  0.0000D 00    107  0.0000D 00    108  0.0000D 00    109  0.0000D 00    110  0.0000D 00
  111  0.0000D 00    112  0.0000D 00    113  0.0000D 00    114  0.0000D 00    115  0.0000D 00
  116  0.0000D 00    117  0.0000D 00    118  0.0000D 00    119  0.0000D 00    120  0.0000D 00
  121  0.0000D 00    122  0.0000D 00    123  0.0000D 00    124  0.0000D 00    125  0.0000D 00
  126  0.0000D 00    127  0.0000D 00    128  0.0000D 00    129  0.0000D 00    130  0.0000D 00
  131  0.0000D 00    132  0.0000D 00    133  0.0000D 00    134  0.0000D 00    135  0.0000D 00
  136  0.0000D 00    137  0.0000D 00    138  0.0000D 00    139  0.0000D 00    140  0.0000D 00
  141  0.0000D 00    142  0.0000D 00    143  0.0000D 00    144  0.0000D 00    145  0.0000D 00
  146  0.0000D 00    147  0.0000D 00    148  0.0000D 00    149  0.0000D 00    150  0.0000D 00
  151  0.0000D 00    152  0.0000D 00    153  0.0000D 00    154  0.0000D 00    155  0.0000D 00
  156  0.0000D 00    157  0.0000D 00    158  0.0000D 00    159  0.0000D 00    160  0.0000D 00
  161  0.0000D 00    162  0.0000D 00    163  0.0000D 00    164  0.0000D 00    165  0.0000D 00
  166  0.0000D 00    167  0.0000D 00    168  0.0000D 00    169  0.0000D 00    170  0.0000D 00
  171  0.0000D 00    172  0.0000D 00    173  0.0000D 00    174  0.0000D 00    175  0.0000D 00
  176  0.0000D 00
```

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                                CONC DISTRIBUTION AT TIME =  10.000 DAYS
 NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

     1    0.000D 00        2    0.000D 00        3    0.000D 00        4    0.370D-02        5    0.564D-02
     6    0.666D-02        7    0.577D-02        8    0.387D-02        9    0.195D 02       10    0.980D-03
    11    0.000D 00       12    0.000D 00       13    0.236D-01       14    0.414D-01       15    0.481D-01
    16    0.461D-01       17    0.400D-01       18    0.318D-01       19    0.233D-01       20    0.166D-01
    21    0.118D-01       22    0.788D-02       23    0.100D 01       24    0.822D 00       25    0.763D 00
    26    0.697D 00       27    0.646D 00       28    0.601D 00       29    0.567D 00       30    0.541D 00
    31    0.587D 00       32    0.511D 00       33    0.504D 00       34    0.100D 01       35    0.727D 00
    36    0.565D 00       37    0.420D 00       38    0.305D 00       39    0.212D 00       40    0.141D 00
    41    0.912D-01       42    0.547D-01       43    0.314D-01       44    0.168D-01       45    0.100D 01
    46    0.740D 00       47    0.586D 00       48    0.441D 00       49    0.322D 00       50    0.225D 00
    51    0.151D 00       52    0.959D-01       53    0.586D-01       54    0.289D-01       55    0.500D-04
    56    0.100D 01       57    0.827D 00       58    0.763D 00       59    0.697D 00       60    0.646D 00
    61    0.601D 00       62    0.567D 00       63    0.541D 00       64    0.529D 00       65    0.511D 00
    66    0.504D 00       67    0.000D 00       68    0.236D-01       69    0.414D-01       70    0.481D-01
    71    0.461D-01       72    0.400D-01       73    0.318D-01       74    0.233D-01       75    0.166D-01
    76    0.118D-01       77    0.788D-02       78    0.000D 00       79    0.000D 00       80    0.000D 00
    81    0.370D-02       82    0.564D-02       83    0.666D-02       84    0.577D-02       85    0.387D-02
    86    0.195D-02       87    0.980D-03       88    0.000D 00       89    0.000D 00       90    0.000D 00
    91    0.000D 00       92    0.370D-02       93    0.564D-02       94    0.666D-02       95    0.577D-02
    96    0.387D-02       97    0.195D-02       98    0.980D-03       99    0.000D 00      100    0.000D 00
   101    0.236D-01      102    0.414D-01      103    0.481D-01      104    0.461D-01      105    0.400D-01
   106    0.318D-01      107    0.233D-01      108    0.166D-01      109    0.118D-01      110    0.788D-02
   111    0.100D 01      112    0.822D 00      113    0.763D 00      114    0.697D 00      115    0.646D 00
   116    0.601D 00      117    0.567D 00      118    0.541D 00      119    0.587D 00      120    0.511D 00
   121    0.504D 00      122    0.100D 01      123    0.727D 00      124    0.565D 00      125    0.420D 00
   126    0.305D 00      127    0.212D 00      128    0.141D 00      129    0.912D-01      130    0.547D-01
   131    0.314D-01      132    0.168D-01      133    0.100D 01      134    0.740D 00      135    0.586D 00
   136    0.441D 00      137    0.322D 00      138    0.225D 00      139    0.151D 00      140    0.959D-01
   141    0.586D-01      142    0.289D-01      143    0.500D-04      144    0.100D 01      145    0.827D 00
   146    0.763D 00      147    0.697D 00      148    0.646D 00      149    0.601D 00      150    0.567D 00
   151    0.541D 00      152    0.529D 00      153    0.511D 00      154    0.504D 00      155    0.000D 00
   156    0.236D-01      157    0.414D-01      158    0.481D-01      159    0.461D-01      160    0.400D-01
   161    0.318D-01      162    0.233D-01      163    0.166D-01      164    0.118D-01      165    0.788D-02
   166    0.000D 00      167    0.000D 00      168    0.000D 00      169    0.370D-02      170    0.564D-02
   171    0.666D-02      172    0.577D-02      173    0.387D-02      174    0.195D-02      175    0.980D-03
   176    0.000D 00
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                                  CONC DISTRIBUTION AT TIME =  20 000  DAYS
NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

   1     0 000D 00      2     0.275D-02      3     0.130D-01      4     0 234D-01      5     0.322D-01
   6     0 383D-01      7     0 396D-01      8     0 389D-01      9     0 354D-01     10     0.296D-01
  11     0 247D-01     12     0.000D 00     13     0.367D-01     14     0.678D-01     15     0 860D-01
  16     0 938D-01     17     0.928D-01     18     0 859D-01     19     0 759D-01     20     0 659D-01
  21     0 543D-01     22     0 435D-01     23     0.100D 01     24     0 867D 00     25     0 827D 00
  26     0 783D 00     27     0 744D 00     28     0.707D 00     29     0 672D 00     30     0 639D 00
  31     0 613D 00     32     0.587D 00     33     0.566D 00     34     0 100D 01     35     0.780D 00
  36     0 654D 00     37     0.539D 00     38     0 441D 00     39     0 357D 00     40     0 285D 00
  41     0 224D 00     42     0 174D 00     43     0 131D 00     44     0 979D-01     45     0 100D 01
  46     0 796D 00     47     0 671D 00     48     0 565D 00     49     0 465D 00     50     0 376D 00
  51     0 300D 00     52     0 235D 00     53     0 183D 00     54     0.138D 00     55     0.103D 00
  56     0 100D 01     57     0 867D 00     58     0.827D 00     59     0 783D 00     60     0 744D 00
  61     0 707D 00     62     0.672D 00     63     0 639D 00     64     0.613D 00     65     0 587D 00
  66     0 566D 00     67     0.000D 00     68     0 367D-01     69     0 678D-01     70     0.860D-01
  71     0 938D-01     72     0 928D-01     73     0 859D-01     74     0 759D-01     75     0.659D-01
  76     0.543D-01     77     0.432D-01     78     0.000D 00     79     0 275D-02     80     0.130D-01
  81     0.233D-02     82     0.322D-01     83     0.383D-01     84     0 396D-01     85     0 389D-01
  86     0.354D-01     87     0.296D-01     88     0.247D-01     89     0.000D 00     90     0.275D-02
  91     0 130D-01     92     0 234D-01     93     0.322D-01     94     0 383D-01     95     0 396D-01
  96     0 389D-01     97     0 354D-01     98     0 296D-01     99     0.247D-01    100     0 000D 00
 101     0 367D-01    102     0 678D-01    103     0 860D-01    104     0 938D-01    105     0 928D-01
 106     0 859D-01    107     0.759D-01    108     0.659D-01    109     0.543D-01    110     0.435D-01
 111     0.100D 01    112     0 867D 00    113     0.827D 00    114     0 783D 00    115     0 744D 00
 116     0 707D 00    117     0 672D 00    118     0 639D 00    119     0 613D 00    120     0 587D 00
 121     0 566D 00    122     0 100D 01    123     0.780D 00    124     0 654D 00    125     0.539D 00
 126     0 441D 00    127     0.357D 00    128     0.285D 00    129     0 224D 00    130     0.174D 00
 131     0 131D 00    132     0.879D-01    133     0.100D 01    134     0.796D 00    135     0 671D 00
 136     0 565D 00    137     0.465D 00    138     0.376D 00    139     0.300D 00    140     0.235D 00
 141     0.183D 00    142     0 138D 00    143     0.103D 00    144     0.100D 01    145     0 867D 00
 146     0 827D 00    147     0.783D 00    148     0.744D 00    149     0.707D 00    150     0 672D 00
 151     0 639D 00    152     0.613D 00    153     0.587D 00    154     0 566D 00    155     0 000D 00
 156     0 367D-01    157     0 678D-01    158     0.860D-01    159     0 938D-01    160     0.928D-01
 161     0 859D-01    162     0.759D-01    163     0 659D-01    164     0.543D-01    165     0.432D-01
 166     0.000D 00    167     0.275D-02    168     0.130D-01    169     0 233D-02    170     0.322D-01
 171     0 383D-01    172     0.396D-01    173     0.389D-01    174     0 354D-01    175     0.296D-01
 176     0 247D-01
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                                CONC DISTRIBUTION AT TIME =  30.000 DAYS
 NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS

     1   0.000D 00         2   0.920D-03         3   0.262D-01         4   0.444D-01         5   0.600D-01
     6   0.712D-01         7   0.775D-01         8   0.791D-01         9   0.781D-01        10   0.734D 00
    11   0.655D-01        12   0.000D 00        13   0.455D-01        14   0.853D-01        15   0.112D 00
    16   0.128D 00        17   0.133D 00        18   0.132D 00        19   0.127D 00        20   0.117D 00
    21   0.105D 00        22   0.923D-01        23   0.100D 01        24   0.891D 00        25   0.860D 00
    26   0.828D 00        27   0.798D 00        28   0.768D 00        29   0.737D 00        30   0.709D 00
    31   0.685D 00        32   0.657D 00        33   0.631D 00        34   0.100D 01        35   0.806D 00
    36   0.694D 00        37   0.592D 00        38   0.505D 00        39   0.430D 00        40   0.364D 00
    41   0.307D 00        42   0.258D 00        43   0.213D 00        44   0.175D 00        45   0.100D 01
    46   0.823D 00        47   0.720D 00        48   0.620D 00        49   0.530D 00        50   0.451D 00
    51   0.382D 00        52   0.321D 00        53   0.269D 00        54   0.222D 00        55   0.182D 00
    56   0.100D 01        57   0.891D 00        58   0.860D 00        59   0.828D 00        60   0.798D 00
    61   0.768D 00        62   0.737D 00        63   0.709D 00        64   0.685D 00        65   0.657D 00
    66   0.631D 00        67   0.000D 00        68   0.455D-01        69   0.853D-01        70   0.112D 00
    71   0.128D 00        72   0.133D 00        73   0.132D 00        74   0.127D 00        75   0.117D 00
    76   0.105D 00        77   0.923D-01        78   0.000D 00        79   0.920D-03        80   0.262D-01
    81   0.444D-01        82   0.600D-01        83   0.712D-01        84   0.775D-01        85   0.791D-01
    86   0.781D-01        87   0.733D-01        88   0.655D-01        89   0.000D 00        90   0.920D-03
    91   0.262D-01        92   0.444D-01        93   0.600D-01        94   0.712D-01        95   0.775D-01
    96   0.791D-01        97   0.781D-01        98   0.734D 00        99   0.655D-01       100   0.000D 00
   101   0.455D-01       102   0.853D-01       103   0.112D 00       104   0.128D 00       105   0.133D 00
   106   0.132D 00       107   0.127D 00       108   0.117D 00       109   0.105D 00       110   0.923D-01
   111   0.100D 01       112   0.891D 00       113   0.860D 00       114   0.828D 00       115   0.798D 00
   116   0.768D 00       117   0.737D 00       118   0.709D 00       119   0.685D 00       120   0.657D 00
   121   0.631D 00       122   0.100D 01       123   0.806D 00       124   0.694D 00       125   0.592D 00
   126   0.505D 00       127   0.430D 00       128   0.364D 00       129   0.307D 00       130   0.258D 00
   131   0.213D 00       132   0.175D 00       133   0.100D 01       134   0.823D 00       135   0.720D 00
   136   0.620D 00       137   0.530D 00       138   0.451D 00       139   0.382D 00       140   0.321D 00
   141   0.269D 00       142   0.222D 00       143   0.182D 00       144   0.100D 01       145   0.891D 00
   146   0.860D 00       147   0.828D 00       148   0.798D 00       149   0.768D 00       150   0.737D 00
   151   0.709D 00       152   0.685D 00       153   0.657D 00       154   0.631D 00       155   0.000D 00
   156   0.455D-01       157   0.853D-01       158   0.112D 00       159   0.128D 00       160   0.133D 00
   161   0.132D 00       162   0.127D 00       163   0.117D 00       164   0.105D 00       165   0.923D-01
   166   0.000D 00       167   0.920D-03       168   0.262D-01       169   0.444D-01       170   0.600D-01
   171   0.712D-01       172   0.775D-01       173   0.791D-01       174   0.781D-01       175   0.733D-01
   176   0.655D-01
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                              CONC DISTRIBUTION AT TIME =  40 000  DAYS
NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS

    1   0 000D 00       2   0.150D-01       3   0.378D-01       4   0.620D-01       5   0.825D-01
    6   0 997D-01       7   0.110D 00       8   0.117D 00       9   0 117D 00      10   0.116D 00
   11   0 110D 00      12   0 000D 00      13   0.526D-01      14   0.993D-01      15   0.133D 00
   16   0 153D 00      17   0.165D 00      18   0.167D 00      19   0 166D 00      20   0.162D 00
   21   0 152D 00      22   0.140D 00      23   0.100D 01      24   0 909D 00      25   0 884D 00
   26   0 860D 00      27   0 833D 00      28   0.809D 00      29   0.782D 00      30   0.759D 00
   31   0 744D 00      32   0.716D 00      33   0 690D 00      34   0.100D 01      35   0.825D 00
   36   0 718D 00      37   0 625D 00      38   0.543D 00      39   0 474D 00      40   0.413D 00
   41   0 361D 00      42   0 318D 00      43   0 274D 00      44   0 236D 00      45   0.100D 01
   46   0 842D 00      47   0 745D 00      48   0 653D 00      49   0.569D 00      50   0 496D 00
   51   0 431D 00      52   0.376D 00      53   0.330D 00      54   0 284D 00      55   0 243D 00
   56   0.100D 01      57   0.909D 00      58   0.884D 00      59   0.860D 00      60   0.833D 00
   61   0 809D 00      62   0 782D 00      63   0 753D 00      64   0.744D 00      65   0 716D 00
   66   0 690D 00      67   0 000D 00      68   0 526D-01      69   0.993D-01      70   0.133D 00
   71   0 153D 00      72   0.165D 00      73   0.167D 00      74   0.165D 00      75   0.162D 00
   76   0 152D 00      77   0.140D 00      78   0.000D 00      79   0.150D-01      80   0.378D-01
   81   0 620D-01      82   0 825D-01      83   0 997D-01      84   0.110D-01      85   0.117D-01
   86   0.117D-01      87   0.116D 00      88   0 110D 00      89   0.000D 00      90   0.150D-01
   91   0 378D-01      92   0.620D-01      93   0.825D-01      94   0.997D-01      95   0.110D 00
   96   0 117D 00      97   0.117D 00      98   0.116D 00      99   0 110D 00     100   0 000D 00
  101   0 526D-01     102   0 993D-01     103   0.133D 00     104   0.153D 00     105   0.165D 00
  106   0 167D 00     107   0.166D 00     108   0.162D 00     109   0.152D 00     110   0 140D 00
  111   0 100D 01     112   0.909D 00     113   0.884D 00     114   0 860D 00     115   0.833D 00
  116   0 809D 00     117   0 782D 00     118   0.759D 00     119   0.744D 00     120   0.716D 00
  121   0.690D 00     122   0.100D 01     123   0.825D 00     124   0 718D 00     125   0.625D 00
  126   0 543D 00     127   0 474D 00     128   0.413D 00     129   0.361D 00     130   0 318D 00
  131   0.274D 00     132   0.236D 00     133   0.100D 01     134   0 842D 00     135   0.745D 00
  136   0 653D 00     137   0 569D 00     138   0.496D 00     139   0.431D 00     140   0.376D 00
  141   0 330D 00     142   0 284D 00     143   0.243D 00     144   0 100D 01     145   0 909D 00
  146   0 884D 00     147   0 860D 00     148   0.833D 00     149   0.809D 00     150   0 782D 00
  151   0 753D 00     152   0 744D 00     153   0 716D 00     154   0.690D 00     155   0 000D 00
  156   0.526D-01     157   0.993D-01     158   0.133D 00     159   0.153D 00     160   0.165D 00
  161   0 167D 00     162   0.165D 00     163   0.162D 00     164   0 152D 00     165   0 140D 00
  166   0 000D 00     167   0 150D-01     168   0.378D-01     169   0 620D-01     170   0 825D-01
  171   0 997D-01     172   0.110D-01     173   0.117D-01     174   0 117D-01     175   0 116D 00
  176   0 110D 00
```

```
                                        CONC DISTRIBUTION AT TIME =  80.000 DAYS
NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

    1   0.0000D 00       2   0.2000D-01       3   0.4770D-01       4   0.7060D-01       5   0.1010D 00
    6   0.1220D 00       7   0.1360D 00       8   0.1470D 00       9   0.1530D 00      10   0.1530D 00
   11   0.1470D 00      12   0.0000D 00      13   0.5800D-01      14   0.1100D 00      15   0.1480D 00
   16   0.1740D 00      17   0.1890D 00      18   0.1960D 00      19   0.1960D 00      20   0.1970D 00
   21   0.1900D 00      22   0.1800D 00      23   0.1000D 01      24   0.9250D 00      25   0.9020D 00
   26   0.8840D 00      27   0.8590D 00      28   0.8400D 00      29   0.8150D 00      30   0.7970D 00
   31   0.7830D 00      32   0.7580D 00      33   0.7830D 00      34   0.1000D 01      35   0.8410D 00
   36   0.7360D 00      37   0.6470D 00      38   0.5680D 00      39   0.5040D 00      40   0.4470D 00
   41   0.3990D 00      42   0.3590D 00      43   0.3180D 00      44   0.2810D 00      45   0.1000D 01
   46   0.9020D 00      47   0.8000D 00      48   0.7030D 00      49   0.6160D 00      50   0.5410D 00
   51   0.4770D 00      52   0.4210D 00      53   0.3720D 00      54   0.3280D 00      55   0.2890D 00
   56   0.1000D 01      57   0.9250D 00      58   0.9020D 00      59   0.8840D 00      60   0.8590D 00
   61   0.8400D 00      62   0.8150D 00      63   0.7970D 00      64   0.7830D 00      65   0.7580D 00
   66   0.7830D 00      67   0.0000D 00      68   0.5800D-01      69   0.1080D 00      70   0.1480D 00
   71   0.1740D 00      72   0.1890D 00      73   0.1960D 00      74   0.1960D 00      75   0.1970D 00
   76   0.1900D 00      77   0.1800D 00      78   0.0000D 00      79   0.2000D-01      80   0.4770D-01
   81   0.7060D 00      82   0.1010D 00      83   0.1220D 00      84   0.1360D 00      85   0.1470D 00
   86   0.1530D 00      87   0.1530D 00      88   0.1470D 00      89   0.0000D 00      90   0.2000D-01
   91   0.4770D-01      92   0.7060D-01      93   0.1010D 00      94   0.1220D 00      95   0.1360D 00
   96   0.1470D 00      97   0.1530D 00      98   0.1530D 00      99   0.1470D 00     100   0.0000D 00
  101   0.5800D-01     102   0.1100D 00     103   0.1480D 00     104   0.1740D 00     105   0.1890D 00
  106   0.1960D 00     107   0.1960D 00     108   0.1970D 00     109   0.1900D 00     110   0.1800D 00
  111   0.1000D 01     112   0.9250D 00     113   0.9020D 00     114   0.8840D 00     115   0.8590D 00
  116   0.8400D 00     117   0.8150D 00     118   0.7970D 00     119   0.7830D 00     120   0.7580D 00
  121   0.7830D 00     122   0.1000D 01     123   0.8410D 00     124   0.7360D 00     125   0.6470D 00
  126   0.5680D 00     127   0.5040D 00     128   0.4470D 00     129   0.3990D 00     130   0.3590D 00
  131   0.3180D 00     132   0.2810D 00     133   0.1000D 01     134   0.9020D 00     135   0.8000D 00
  136   0.7030D 00     137   0.6160D 00     138   0.5410D 00     139   0.4770D 00     140   0.4210D 00
  141   0.3720D 00     142   0.3280D 00     143   0.2890D 00     144   0.1000D 01     145   0.9250D 00
  146   0.9020D 00     147   0.8840D 00     148   0.8590D 00     149   0.8400D 00     150   0.8150D 00
  151   0.7970D 00     152   0.7830D 00     153   0.7580D 00     154   0.7830D 00     155   0.0000D 00
  156   0.5800D-01     157   0.1080D 00     158   0.1480D 00     159   0.1740D 00     160   0.1890D 00
  161   0.1960D 00     162   0.1960D 00     163   0.1970D 00     164   0.1900D 00     165   0.1800D 00
  166   0.0000D 00     167   0.2000D-01     168   0.4770D-01     169   0.7060D 00     170   0.1010D 00
  171   0.1220D 00     172   0.1360D 00     173   0.1470D 00     174   0.1530D 00     175   0.1530D 00
  176   0.1470D 00
```

100 Elements

```
                        INPUT DATA FOR THREE-DIMENSIONAL
                        --------------------------------
                   GROUNDWATER DISP BY FINITE ELEMENT METHOD
                   -----------------------------------------

TOTAL NO  OF ELEMENTS              = 100
TOTAL NO  OF NODES                 = 242
MAXIMUM NO. OF NODES PER ELEMENT   =   8
TOTAL NO. OF MATERIALS             =   1
NUMBER OF PUMPING WELLS            =   0
NUMBER OF CONCS TO BE ESTIMATED    = 228



NUMBER OF PUMPING PERIODS          =   0
TOTAL SIMULATION PERIODS           =   5
FACTOR MULTIPLYING COMPUTED CONCS  =   1 00000



STEP SIZE                          =  10 00000
STATE OF PROBLEM                   =   1
NO  OF SPECIFIED CONDITIONS        =  80
```

```
                   COORDINATES AND INITIAL CONCS OF NODES (L)

NODES        Y(I)          X(I)          Z(I)          CINI(I)

    1      0.000 00      0.000 00      0.100 03      0.000 00
    2      0.100 02      0.000 00      0.100 03      0.000 00
    3      0.200 02      0.000 00      0.100 03      0.000 00
    4      0.300 02      0.000 00      0.100 03      0.000 00
    5      0.400 02      0.000 00      0.100 03      0.000 00
    6      0.500 02      0.000 00      0.100 03      0.000 00
    7      0.600 02      0.000 00      0.100 03      0.000 00
    8      0.700 02      0.000 00      0.100 03      0.000 00
    9      0.800 02      0.000 00      0.100 03      0.000 00
   10      0.900 02      0.000 00      0.100 03      0.000 00
   11      0.100 03      0.000 00      0.100 03      0.000 00
   12      0.000 00      0.100 02      0.100 03      0.000 00
   13      0.100 02      0.100 02      0.100 03      0.000 00
   14      0.200 02      0.100 02      0.100 03      0.000 00
   15      0.300 02      0.100 02      0.100 03      0.000 00
   16      0.400 02      0.100 02      0.100 03      0.000 00
   17      0.500 02      0.100 02      0.100 03      0.000 00
   18      0.600 02      0.100 02      0.100 03      0.000 00
   19      0.700 02      0.100 02      0.100 03      0.000 00
   20      0.800 02      0.100 02      0.100 03      0.000 00
   21      0.900 02      0.100 02      0.100 03      0.000 00
   22      0.100 03      0.100 02      0.100 03      0.000 00
   23      0.000 00      0.200 02      0.100 03      0.100 01
   24      0.100 02      0.200 02      0.100 03      0.000 00
   25      0.200 02      0.200 02      0.100 03      0.000 00
   26      0.300 02      0.200 02      0.100 03      0.000 00
   27      0.400 02      0.200 02      0.100 03      0.000 00
   28      0.500 02      0.200 02      0.100 03      0.000 00
   29      0.600 02      0.200 02      0.100 03      0.000 00
   30      0.700 02      0.200 02      0.100 03      0.000 00
   31      0.800 02      0.200 02      0.100 03      0.000 00
   32      0.900 02      0.200 02      0.100 03      0.000 00
   33      0.100 03      0.200 02      0.100 03      0.000 00
   34      0.000 00      0.250 02      0.100 03      0.100 01
   35      0.100 02      0.250 02      0.100 03      0.000 00
   36      0.200 02      0.250 02      0.100 03      0.000 00
   37      0.300 02      0.250 02      0.100 03      0.000 00
   38      0.400 02      0.250 02      0.100 03      0.000 00
   39      0.500 02      0.250 02      0.100 03      0.000 00
   40      0.600 02      0.250 02      0.100 03      0.000 00
   41      0.700 02      0.250 02      0.100 03      0.000 00
   42      0.800 02      0.250 02      0.100 03      0.000 00
   43      0.900 02      0.250 02      0.100 03      0.000 00
   44      0.100 03      0.250 02      0.100 03      0.000 00
   45      0.000 00      0.300 02      0.100 03      0.100 01
   46      0.100 02      0.300 02      0.100 03      0.000 00
   47      0.200 02      0.300 02      0.100 03      0.000 00
```

```
 48    0 300 02   0 300 02   0 100 03   0 000 00
 49    0 400 02   0.300 02   0 100 03   0 000 00
 50    0.500 02   0 300 02   0.100 03   0 000 00
 51    0 600 02   0 300 02   0.100 03   0 000 00
 52    0 700 02   0 300 02   0 100 03   0.000 00
 53    0.800 02   0.300 02   0 100 03   0 000 00
 54    0.900 02   0.300 02   0.100 03   0 000 00
 55    0.100 03   0.300 02   0.100 03   0 000 00
 56    0.000 00   0.350 02   0.100 03   0 100 01
 57    0.100 02   0 350 02   0 100 03   0 000 00
 58    0.200 02   0 350 02   0 100 03   0 000 00
 59    0 300 02   0.350 02   0 100 03   0 000 00
 60    0.400 02   0 350 02   0 100 03   0 000 00
 61    0 500 02   0.350 02   0.100 03   0 000 00
 62    0.600 02   0.350 02   0 100 03   0 000 00
 63    0 700 02   0.350 02   0.100 03   0.000 00
 64    0 800 02   0.350 02   0.100 03   0.000 00
 65    0.900 02   0.350 02   0.100 03   0 000 00
 66    0.100 03   0.350 02   0.100 03   0 000 00
 67    0 000 00   0 400 02   0 100 03   0.100 01
 68    0.100 02   0 400 02   0.100 03   0 000 00
 69    0.200 02   0 400 02   0.100 03   0 000 00
 70    0.300 02   0.400 02   0 100 03   0.000 00
 71    0.400 02   0 400 02   0.100 03   0 000 00
 72    0 500 02   0 400 02   0.100 03   0 000 00
 73    0 600 02   0 400 02   0 100 03   0 000 00
 74    0 700 02   0.400 02   0.100 03   0 000 00
 75    0.800 02   0 400 02   0.100 03   0 000 00
 76    0.900 02   0.400 02   0.100 03   0.000 00
 77    0 100 03   0.400 02   0.100 03   0.000 00
 78    0.000 00   0.450 02   0.100 03   0.100 01
 79    0 100 02   0.450 02   0.100 03   0.000 00
 80    0.200 02   0.450 02   0.100 03   0.000 00
 81    0.300 02   0 450 02   0.100 03   0.000 00
 82    0.400 02   0 450 02   0.100 03   0.000 00
 83    0.500 02   0 450 02   0.100 03   0.000 00
 84    0.600 02   0.450 02   0.100 03   0 000 00
 85    0.700 02   0 450 02   0.100 03   0 000 00
 86    0 800 02   0 450 02   0.100 03   0.000 00
 87    0 900 02   0 450 02   0 100 03   0 000 00
 88    0.100 03   0 450 02   0.100 03   0 000 00
 89    0.000 00   0 500 02   0.100 03   0 100 01
 90    0.100 02   0 500 02   0.100 03   0.000 00
 91    0.200 02   0 500 02   0.100 03   0.000 00
 92    0.300 02   0 500 02   0.100 03   0.000 00
 93    0.400 02   0.500 02   0 100 03   0 000 00
 94    0 500 02   0 500 02   0.100 03   0 000 00
 95    0 600 02   0 500 02   0.100 03   0 000 00
 96    0 700 02   0 500 02   0.100 03   0.000 00
 97    0 800 02   0 500 02   0.100 03   0 000 00
 98    0.900 02   0 500 02   0 100 03   0 000 00
 99    0.100 03   0 500 02   0 100 03   0 000 00
100    0 000 00   0.600 02   0.100 03   0 000 00
101    0 100 02   0 600 02   0.100 03   0 000 00
102    0 200 02   0 600 02   0.100 03   0.000 00
103    0.300 02   0 600 02   0 100 03   0.000 00
104    0 400 02   0 600 02   0 100 03   0 000 00
105    0.500 02   0.600 02   0 100 03   0 000 00
106    0 600 02   0 600 02   0 100 03   0 000 00
107    0 700 02   0.600 02   0 100 03   0 000 00

108    0 800 02   0.600 02   0 100 03   0 000 00
109    0 900 02   0.600 02   0.100 03   0 000 00
110    0 100 03   0.600 02   0.100 03   0 000 00
111    0 000 00   0.700 02   0.100 03   0 000 00
112    0.100 02   0.700 02   0.100 03   0 000 00
113    0 200 02   0.700 02   0.100 03   0.000 00
114    0.300 02   0.700 02   0.100 03   0.000 00
115    0 400 02   0.700 02   0.100 03   0.000 00
116    0.500 02   0.700 02   0.100 03   0 000 00
117    0 600 02   0.700 02   0 100 03   0 000 00
118    0 700 02   0 700 02   0 100 03   0 000 00
119    0.800 02   0.700 02   0 100 03   0.000 00
120    0 900 02   0.700 02   0.100 03   0.000 00
121    0 100 03   0.700 02   0.100 03   0 000 00
122    0.000 00   0.000 00   0.000 00   0.000 00
123    0 100 02   0.000 00   0.000 00   0.000 00
124    0.200 02   0.000 00   0 000 00   0 000 00
125    0.300 02   0.000 00   0.000 00   0.000 00
126    0.400 02   0.000 00   0.000 00   0.000 00
127    0.500 02   0.000 00   0.000 00   0.000 00
128    0 600 02   0.000 00   0.000 00   0.000 00
129    0 700 02   0.000 00   0.000 00   0.000 00
130    0.800 02   0.000 00   0.000 00   0 000 00
131    0.900 02   0.000 00   0.000 00   0 000 00
132    0.100 03   0.000 00   0 000 00   0 000 00
133    0.000 00   0.100 02   0.000 00   0.000 00
134    0.100 02   0.100 02   0 000 00   0 000 00
135    0.200 02   0.100 02   0 000 00   0 000 00
136    0.300 02   0.100 02   0 000 00   0 000 00
137    0.400 02   0.100 02   0.000 00   0.000 00
138    0.500 02   0.100 02   0.000 00   0.000 00
139    0.600 02   0.100 02   0 000 00   0 000 00
140    0.700 02   0.100 02   0.000 00   0.000 00
141    0.800 02   0.100 02   0.000 00   0.000 00
142    0.900 02   0.100 02   0.000 00   0.000 00
143    0.100 03   0.100 02   0.000 00   0.000 00
144    0 000 00   0.200 02   0.000 00   0.100 01
145    0.100 02   0.200 02   0.000 00   0.000 00
146    0.200 02   0.200 02   0.000 00   0 000 00
147    0.300 02   0.200 02   0.000 00   0 000 00
148    0.400 02   0.200 02   0.000 00   0 000 00
149    0.500 02   0.200 02   0 000 00   0 000 00
150    0.600 02   0.200 02   0.000 00   0 000 00
151    0.700 02   0.200 02   0 000 00   0 000 00
152    0 800 02   0 200 02   0.000 00   0 000 00
153    0 900 02   0.200 02   0 000 00   0 000 00
154    0 100 03   0 200 02   0 000 00   0 000 00
155    0.000 00   0.250 02   0.000 00   0 100 01
156    0 100 02   0.250 02   0 000 00   0 000 00
157    0.200 02   0.250 02   0 000 00   0 000 00
158    0.300 02   0.250 02   0 000 00   0 000 00
159    0 400 02   0.250 02   0 000 00   0 000 00
160    0.500 02   0 250 02   0.000 00   0 000 00
161    0 600 02   0.250 02   0 000 00   0 000 00
162    0 700 02   0.250 02   0.000 00   0 000 00
163    0 800 02   0.250 02   0.000 00   0 000 00
164    0 900 02   0 250 02   0 000 00   0 000 00
165    0 100 03   0 250 02   0 000 00   0 000 00
166    0 000 00   0 300 02   0 000 00   0 100 01
167    0 100 02   0 300 02   0 000 00   0 000 00
```

```
168   0.200 02   0.300 02   0.000 00   0.000 00
169   0.300 02   0.300 02   0.000 00   0.000 00
170   0.400 02   0.300 02   0.000 00   0.000 00
171   0.500 02   0.300 02   0.000 00   0.000 00
172   0.600 02   0.300 02   0.000 00   0.000 00
173   0.700 02   0.300 02   0.000 00   0.000 00
174   0.800 02   0.300 02   0.000 00   0.000 00
175   0.900 02   0.300 02   0.000 00   0.000 00
176   0.100 03   0.300 02   0.000 00   0.000 00
177   0.000 00   0.350 01   0.000 00   0.100 01
178   0.100 02   0.350 02   0.000 00   0.000 00
179   0.200 02   0.350 02   0.000 00   0.000 00
180   0.300 02   0.350 02   0.000 00   0.000 00
181   0.400 02   0.350 02   0.000 00   0.000 00
182   0.500 02   0.350 02   0.000 00   0.000 00
183   0.600 02   0.350 02   0.000 00   0.000 00
184   0.700 02   0.350 02   0.000 00   0.000 00
185   0.800 02   0.350 02   0.000 00   0.000 00
186   0.900 02   0.350 02   0.000 00   0.000 00
187   0.100 03   0.350 02   0.000 00   0.000 00
188   0.000 00   0.400 02   0.000 00   0.100 01
189   0.100 02   0.400 02   0.000 00   0.000 00
190   0.200 02   0.400 02   0.000 00   0.000 00
191   0.300 02   0.400 02   0.000 00   0.000 00
192   0.400 02   0.400 02   0.000 00   0.000 00
193   0.500 02   0.400 02   0.000 00   0.000 00
194   0.600 02   0.400 02   0.000 00   0.000 00
195   0.700 02   0.400 02   0.000 00   0.000 00
196   0.800 02   0.400 02   0.000 00   0.000 00
197   0.900 02   0.400 02   0.000 00   0.000 00
198   0.100 03   0.400 02   0.000 00   0.000 00
199   0.000 00   0.450 02   0.000 00   0.100 01
200   0.100 02   0.450 02   0.000 00   0.000 00
201   0.200 02   0.450 02   0.000 00   0.000 00
202   0.300 02   0.450 02   0.000 00   0.000 00
203   0.400 02   0.450 02   0.000 00   0.000 00
204   0.500 02   0.450 02   0.000 00   0.000 00
205   0.600 02   0.450 02   0.000 00   0.000 00
206   0.700 02   0.450 02   0.000 00   0.000 00
207   0.800 02   0.450 02   0.000 00   0.000 00
208   0.900 02   0.450 02   0.000 00   0.000 00
209   0.100 03   0.450 02   0.000 00   0.000 00
210   0.000 00   0.500 02   0.000 00   0.100 01
211   0.100 02   0.500 02   0.000 00   0.000 00
212   0.200 02   0.500 02   0.000 00   0.000 00
213   0.300 02   0.500 02   0.000 00   0.000 00
214   0.400 02   0.500 02   0.000 00   0.000 00
215   0.500 02   0.500 02   0.000 00   0.000 00
216   0.600 02   0.500 02   0.000 00   0.000 00
217   0.700 02   0.500 02   0.000 00   0.000 00
218   0.800 02   0.500 02   0.000 00   0.000 00
219   0.900 02   0.500 02   0.000 00   0.000 00
220   0.100 03   0.500 02   0.000 00   0.000 00
221   0.000 00   0.600 02   0.000 00   0.000 00
222   0.100 02   0.600 02   0.000 00   0.000 00
223   0.200 02   0.600 02   0.000 00   0.000 00
224   0.300 02   0.600 02   0.000 00   0.000 00
225   0.400 02   0.600 02   0.000 00   0.000 00
226   0.500 02   0.600 02   0.000 00   0.000 00
227   0.600 02   0.600 02   0.000 00   0.000 00
```

```
228   0.700 02   0.600 02   0.000 00   0.000 00
229   0.800 02   0.600 02   0.000 00   0.000 00
230   0.900 02   0.600 02   0.000 00   0.000 00
231   0.100 03   0.600 02   0.000 00   0.000 00
232   0.000 00   0.700 02   0.000 00   0.000 00
233   0.100 02   0.700 02   0.000 00   0.000 00
234   0.200 02   0.700 02   0.000 00   0.000 00
235   0.300 02   0.700 02   0.000 00   0.000 00
236   0.400 02   0.700 02   0.000 00   0.000 00
237   0.500 02   0.700 02   0.000 00   0.000 00
238   0.600 02   0.700 02   0.000 00   0.000 00
239   0.700 02   0.700 02   0.000 00   0.000 00
240   0.800 02   0.700 02   0.000 00   0.000 00
241   0.900 02   0.700 02   0.000 00   0.000 00
242   0.100 03   0.700 02   0.000 00   0.000 00
```

NODE-ELEMENT RELATIONSHIP

ELEMS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	12	13	2	122	133	134	123
2	2	13	14	3	123	134	135	124
3	3	14	15	4	124	135	136	125
4	4	15	16	5	125	136	137	126
5	5	16	17	6	126	137	138	127
6	6	17	18	7	127	138	139	128
7	7	18	19	8	128	139	140	129
8	8	19	20	9	129	140	141	130
9	9	20	21	10	130	141	142	131
10	10	21	22	11	131	142	143	132
11	12	23	24	13	133	144	145	134
12	13	24	25	14	134	145	146	135
13	14	25	26	15	135	146	147	136
14	15	26	27	16	136	147	148	137
15	16	27	28	17	137	148	149	138
16	17	28	29	18	138	149	150	139
17	18	29	30	19	139	150	151	140
18	19	30	31	20	140	151	152	141
19	20	31	32	21	141	152	153	142
20	21	32	33	22	142	153	154	143
21	23	34	35	24	144	155	156	145
22	24	35	36	25	145	156	157	146
23	25	36	37	26	146	157	158	147
24	26	37	38	27	147	158	159	148
25	27	38	39	28	148	159	160	149
26	28	39	40	29	149	160	161	150
27	29	40	41	30	150	161	162	151
28	30	41	42	31	151	162	163	152
29	31	42	43	32	152	163	164	153
30	32	43	44	33	153	164	165	154
31	34	45	46	35	155	166	167	156
32	35	46	47	36	156	167	168	157
33	36	47	48	37	157	168	169	158
34	37	48	49	38	158	169	170	159
35	38	49	50	39	159	170	171	160
36	39	50	51	40	160	171	172	161
37	40	51	52	41	161	172	173	162
38	41	52	53	42	162	173	174	163
39	42	53	54	43	163	174	175	164
40	43	54	55	44	164	175	176	165
41	45	56	57	46	166	177	178	167
42	46	57	58	47	167	178	179	168
43	47	58	59	48	168	179	180	169
44	48	59	60	49	169	180	181	170
45	49	60	61	50	170	181	182	171
46	50	61	62	51	171	182	183	172

47	51	62	63	52	172	183	184	173
48	52	63	64	53	173	184	185	174
49	53	64	65	54	174	185	186	175
50	54	65	66	55	175	186	187	176
51	56	67	68	57	177	188	189	178
52	57	68	69	58	178	189	190	179
53	58	69	70	59	179	190	191	180
54	59	70	71	60	180	191	192	181
55	60	71	72	61	181	192	193	182
56	61	72	73	62	182	193	194	183
57	62	73	74	63	183	194	195	184
58	63	74	75	64	184	195	196	185
59	64	75	76	65	185	196	197	186
60	65	76	77	66	186	197	198	187
61	67	78	79	68	188	199	200	189
62	68	79	80	69	189	200	201	190
63	69	80	81	70	190	201	202	191
64	70	81	82	71	191	202	203	192
65	71	82	83	72	192	203	204	193
66	72	83	84	73	193	204	205	194
67	73	84	85	74	194	205	206	195
68	74	85	86	75	195	206	207	196
69	75	86	87	76	196	207	208	197
70	76	87	88	77	197	208	209	198
71	78	89	90	79	199	210	211	200
72	79	90	91	80	200	211	212	201
73	80	91	92	81	201	212	213	202
74	81	92	93	82	202	213	214	203
75	82	93	94	83	203	214	215	204
76	83	94	95	84	204	215	216	205
77	84	95	96	85	205	216	217	206
78	85	96	97	86	206	217	218	207
79	86	97	98	87	207	218	219	208
80	87	98	99	88	208	219	220	209
81	89	100	101	90	210	221	222	211
82	90	101	102	91	211	222	223	212
83	91	102	103	92	212	223	224	213
84	92	103	104	93	213	224	225	214
85	93	104	105	94	214	225	226	215
86	94	105	106	95	215	226	227	216
87	95	106	107	96	216	227	228	217
88	96	107	108	97	217	228	229	218
89	97	108	109	98	218	229	230	219
90	98	109	110	99	219	230	231	220
91	100	111	112	101	221	232	233	222
92	101	112	113	102	222	233	234	223
93	102	113	114	103	223	234	235	224
94	103	114	115	104	224	235	236	225
95	104	115	116	105	225	236	237	226
96	105	116	117	106	226	237	238	227
97	106	117	118	107	227	238	239	228
98	107	118	119	108	228	239	240	229
99	108	119	120	109	229	240	241	230
100	109	120	121	110	230	241	242	231

```
                              CONC DISTRIBUTION AT TIME =  50.000 DAYS
NODES      CONCS       NODES      CONCS       NODES      CONCS       NODES      CONCS       NODES      CONCS

    1    0.000D 00       2    0.200D-01       3    0.485D-01       4    0.768D-01       5    0.103D 00
    6    0.123D 00       7    0.137D 00       8    0.148D 00       9    0.153D 00      10    0.153D 00
   11    0.149D 00      12    0.000D 00      13    0.590D-01      14    0.112D 00      15    0.142D 00
   16    0.176D 00      17    0.190D 00      18    0.197D 00      19    0.199D 00      20    0.197D 00
   21    0.196D 00      22    0.180D 00      23    0.100D 01      24    0.942D 00      25    0.918D 00
   26    0.892D 00      27    0.869D 00      28    0.846D 00      29    0.821D 00      30    0.802D 00
   31    0.783D 00      32    0.758D 00      33    0.733D 00      34    0.100D 01      35    0.776D 00
   36    0.647D 00      37    0.562D 00      38    0.499D 00      39    0.447D 00      40    0.401D 00
   41    0.363D 00      42    0.329D 00      43    0.294D 00      44    0.263D 00      45    0.100D 01
   46    0.856D 00      47    0.748D 00      48    0.653D 00      49    0.575D 00      50    0.508D 00
   51    0.450D 00      52    0.401D 00      53    0.359D 00      54    0.318D 00      55    0.281D 00
   56    0.100D 01      57    0.873D 00      58    0.776D 00      59    0.683D 00      60    0.602D 00
   61    0.530D 00      62    0.468D 00      63    0.417D 00      64    0.373D 00      65    0.328D 00
   66    0.294D 00      67    0.100D 01      68    0.856D 00      69    0.748D 00      70    0.653D 00
   71    0.575D 00      72    0.508D 00      73    0.450D 00      74    0.401D 00      75    0.359D 00
   76    0.318D 00      77    0.281D 00      78    0.100D 01      79    0.776D 00      80    0.647D 00
   81    0.562D 00      82    0.499D 00      83    0.447D 00      84    0.401D 00      85    0.363D 00
   86    0.329D 00      87    0.294D 00      88    0.263D 00      89    0.100D 01      90    0.942D 00
   91    0.918D 00      92    0.892D 00      93    0.869D 00      94    0.846D 00      95    0.821D 00
   96    0.802D 00      97    0.783D 00      98    0.758D 00      99    0.733D 00     100    0.000D 00
  101    0.590D-01     102    0.112D 00     103    0.142D 00     104    0.176D 00     105    0.190D 00
  106    0.197D 00     107    0.199D 00     108    0.197D 00     109    0.196D 00     110    0.180D 00
  111    0.000D 00     112    0.200D-01     113    0.485D-01     114    0.768D-01     115    0.103D 00
  116    0.123D 00     117    0.137D 00     118    0.148D 00     119    0.153D 00     120    0.153D 00
  121    0.149D 00     122    0.000D 00     123    0.200D-01     124    0.485D-01     125    0.768D-01
  126    0.103D 00     127    0.123D 00     128    0.137D 00     129    0.148D 00     130    0.153D 00
  131    0.153D 00     132    0.149D 00     133    0.000D 00     134    0.590D-01     135    0.112D 00
  136    0.142D 00     137    0.176D 00     138    0.190D 00     139    0.197D 00     140    0.199D 00
  141    0.197D 00     142    0.196D 00     143    0.180D 00     144    0.100D 01     145    0.942D 00
  146    0.918D 00     147    0.892D 00     148    0.869D 00     149    0.846D 00     150    0.821D 00
  151    0.802D 00     152    0.783D 00     153    0.758D 00     154    0.733D 00     155    0.100D 01
  156    0.776D 00     157    0.647D 00     158    0.562D 00     159    0.499D 00     160    0.447D 00
  161    0.401D 00     162    0.363D 00     163    0.329D 00     164    0.294D 00     165    0.263D 00
  166    0.100D 01     167    0.856D 00     168    0.748D 00     169    0.653D 00     170    0.575D 00
  171    0.508D 00     172    0.450D 00     173    0.401D 00     174    0.359D 00     175    0.318D 00
  176    0.281D 00     177    0.100D 01     178    0.873D 00     179    0.776D 00     180    0.683D 00
  181    0.602D 00     182    0.530D 00     183    0.468D 00     184    0.417D 00     185    0.373D 00
  186    0.328D 00     187    0.294D 00     188    0.100D 01     189    0.856D 00     190    0.748D 00
  191    0.653D 00     192    0.575D 00     193    0.508D 00     194    0.450D 00     195    0.401D 00
  196    0.359D 00     197    0.318D 00     198    0.281D 00     199    0.100D 01     200    0.776D 00
  201    0.647D 00     202    0.562D 00     203    0.499D 00     204    0.447D 00     205    0.401D 00
  206    0.363D 00     207    0.329D 00     208    0.294D 00     209    0.263D 00     210    0.100D 01
  211    0.942D 00     212    0.918D 00     213    0.892D 00     214    0.869D 00     215    0.846D 00
  216    0.821D 00     217    0.802D 00     218    0.783D 00     219    0.758D 00     220    0.733D 00
  221    0.000D 00     222    0.590D-01     223    0.112D 00     224    0.142D 00     225    0.176D 00
  226    0.190D 00     227    0.197D 00     228    0.199D 00     229    0.197D 00     230    0.196D 00
  231    0.180D 00     232    0.000D 00     233    0.200D-01     234    0.485D-01     235    0.768D-01
  236    0.103D 00     237    0.123D 00     238    0.137D 00     239    0.148D 00     240    0.153D 00
  241    0.153D 00     242    0.149D 00
```

APPENDIX D

INPUT/OUTPUT OF TWO-DIMENSIONAL TESTING

```
                     INPUT DATA FOR THREE-DIMENSIONAL
                     --------------------------------
                  GROUNDWATER DISP BY FINITE ELEMENT METHOD
                  -----------------------------------------

TOTAL NO  OF ELEMENTS              =  81
TOTAL NO  OF NODES                 = 200
MAXIMUM NO. OF NODES PER ELEMENT   =   8
TOTAL NO  OF MATERIALS             =   1
NUMBER OF PUMPING WELLS            =   0
NUMBER OF CONCS TO BE ESTIMATED    = 180



NUMBER OF PUMPING PERIODS          =   0
TOTAL SIMULATION PERIODS           =   7
FACTOR MULTIPLYING COMPUTED CONCS  =   1 00000



STEP SIZE                          =  25 00000
STATE OF PROBLEM                   =   1
NO  OF SPECIFIED CONDITIONS        =  62
```

```
               COORDINATES AND INITIAL CONCS OF NODES (L)

NODES        Y(I)          X(I)          Z(I)         CINT(I)

   1      0.00D 00      0.00D 00      0.10D 02      0.80D-02
   2      0.10D 03      0.00D 00      0.10D 02      0.70D-01
   3      0.20D 03      0.00D 00      0.10D 02      0.31D 00
   4      0.30D 03      0.00D 00      0.10D 02      0.74D 00
   5      0.40D 03      0.00D 00      0.10D 02      0.10D 01
   6      0.50D 03      0.00D 00      0.10D 02      0.74D 00
   7      0.60D 03      0.00D 00      0.10D 02      0.31D 00
   8      0.70D 03      0.00D 00      0.10D 02      0.70D-01
   9      0.80D 03      0.00D 00      0.10D 02      0.90D-02
  10      0.90D 03      0.00D 00      0.10D 02      0.00D 00
  11      0.00D 00      0.20D 03      0.10D 02      0.00D 00
  12      0.10D 03      0.20D 03      0.10D 02      0.00D 00
  13      0.20D 03      0.20D 03      0.10D 02      0.00D 00
  14      0.30D 03      0.20D 03      0.10D 02      0.00D 00
  15      0.40D 03      0.20D 03      0.10D 02      0.00D 00
  16      0.50D 03      0.20D 03      0.10D 02      0.00D 00
  17      0.60D 03      0.20D 03      0.10D 02      0.00D 00
  18      0.70D 03      0.20D 03      0.10D 02      0.00D 00
  19      0.80D 03      0.20D 03      0.10D 02      0.00D 00
  20      0.90D 03      0.20D 03      0.10D 02      0.00D 00
  21      0.00D 00      0.40D 03      0.10D 02      0.00D 00
  22      0.10D 03      0.40D 03      0.10D 02      0.00D 00
  23      0.20D 03      0.40D 03      0.10D 02      0.00D 00
  24      0.30D 03      0.40D 03      0.10D 02      0.00D 00
  25      0.40D 03      0.40D 03      0.10D 02      0.00D 00
  26      0.50D 03      0.40D 03      0.10D 02      0.00D 00
  27      0.60D 03      0.40D 03      0.10D 02      0.00D 00
  28      0.70D 03      0.40D 03      0.10D 02      0.00D 00
  29      0.80D 03      0.40D 03      0.10D 02      0.00D 00
  30      0.90D 03      0.40D 03      0.10D 02      0.00D 00
  31      0.00D 00      0.60D 03      0.10D 02      0.00D 00
  32      0.10D 03      0.60D 03      0.10D 02      0.00D 00
  33      0.20D 03      0.60D 03      0.10D 02      0.00D 00
  34      0.30D 03      0.60D 03      0.10D 02      0.00D 00
  35      0.40D 03      0.60D 03      0.10D 02      0.00D 00
  36      0.50D 03      0.60D 03      0.10D 02      0.00D 00
  37      0.60D 03      0.60D 03      0.10D 02      0.00D 00
  38      0.70D 03      0.60D 03      0.10D 02      0.00D 00
  39      0.80D 03      0.60D 03      0.10D 02      0.00D 00
  40      0.90D 03      0.60D 03      0.10D 02      0.00D 00
  41      0.00D 00      0.80D 03      0.10D 02      0.00D 00
  42      0.10D 03      0.80D 03      0.10D 02      0.00D 00
  43      0.20D 03      0.80D 03      0.10D 02      0.00D 00
  44      0.30D 03      0.80D 03      0.10D 02      0.00D 00
  45      0.40D 03      0.80D 03      0.10D 02      0.00D 00
  46      0.50D 03      0.80D 03      0.10D 02      0.00D 00
  47      0.60D 03      0.80D 03      0.10D 02      0.00D 00
  48      0.70D 03      0.80D 03      0.10D 02      0.00D 00
  49      0.80D 03      0.80D 03      0.10D 02      0.00D 00
  50      0.90D 03      0.80D 03      0.10D 02      0.00D 00
  51      0.00D 00      0.10D 04      0.10D 02      0.00D 00
  52      0.10D 03      0.10D 04      0.10D 02      0.00D 00
  53      0.20D 03      0.10D 04      0.10D 02      0.00D 00
  54      0.30D 03      0.10D 04      0.10D 02      0.00D 00
  55      0.40D 03      0.10D 04      0.10D 02      0.00D 00
  56      0.50D 03      0.10D 04      0.10D 02      0.00D 00
  57      0.60D 03      0.10D 04      0.10D 02      0.00D 00
  58      0.70D 03      0.10D 04      0.10D 02      0.00D 00
  59      0.80D 03      0.10D 04      0.10D 02      0.00D 00
  60      0.90D 03      0.10D 04      0.10D 02      0.00D 00
  61      0.00D 00      0.12D 04      0.10D 02      0.00D 00
  62      0.10D 03      0.12D 04      0.10D 02      0.00D 00
  63      0.20D 03      0.12D 04      0.10D 02      0.00D 00
  64      0.30D 03      0.12D 04      0.10D 02      0.00D 00
  65      0.40D 03      0.12D 04      0.10D 02      0.00D 00
  66      0.50D 03      0.12D 04      0.10D 02      0.00D 00
  67      0.60D 03      0.12D 04      0.10D 02      0.00D 00
  68      0.70D 03      0.12D 04      0.10D 02      0.00D 00
  69      0.80D 03      0.12D 04      0.10D 02      0.00D 00
  70      0.90D 03      0.12D 04      0.10D 02      0.00D 00
  71      0.00D 00      0.14D 04      0.10D 02      0.00D 00
  72      0.10D 03      0.14D 04      0.10D 02      0.00D 00
  73      0.20D 03      0.14D 04      0.10D 02      0.00D 00
  74      0.30D 03      0.14D 04      0.10D 02      0.00D 00
  75      0.40D 03      0.14D 04      0.10D 02      0.00D 00
  76      0.50D 03      0.14D 04      0.10D 02      0.00D 00
  77      0.60D 03      0.14D 04      0.10D 02      0.00D 00
  78      0.70D 03      0.14D 04      0.10D 02      0.00D 00
  79      0.80D 03      0.14D 04      0.10D 02      0.00D 00
  80      0.90D 03      0.14D 04      0.10D 02      0.00D 00
  81      0.00D 00      0.16D 04      0.10D 02      0.00D 00
  82      0.10D 03      0.16D 04      0.10D 02      0.00D 00
  83      0.20D 03      0.16D 04      0.10D 02      0.00D 00
  84      0.30D 03      0.16D 04      0.10D 02      0.00D 00
  85      0.40D 03      0.16D 04      0.10D 02      0.00D 00
  86      0.50D 03      0.16D 04      0.10D 02      0.00D 00
  87      0.60D 03      0.16D 04      0.10D 02      0.00D 00
  88      0.70D 03      0.16D 04      0.10D 02      0.00D 00
  89      0.80D 03      0.16D 04      0.10D 02      0.00D 00
  90      0.90D 03      0.16D 04      0.10D 02      0.00D 00
  91      0.00D 00      0.18D 04      0.10D 02      0.00D 00
  92      0.10D 03      0.18D 04      0.10D 02      0.00D 00
  93      0.20D 03      0.18D 04      0.10D 02      0.00D 00
  94      0.30D 03      0.18D 04      0.10D 02      0.00D 00
  95      0.40D 03      0.18D 04      0.10D 02      0.00D 00
  96      0.50D 03      0.18D 04      0.10D 02      0.00D 00
  97      0.60D 03      0.18D 04      0.10D 02      0.00D 00
  98      0.70D 03      0.18D 04      0.10D 02      0.00D 00
  99      0.80D 03      0.18D 04      0.10D 02      0.00D 00
 100      0.90D 03      0.18D 04      0.10D 02      0.00D 00
 101      0.00D 00      0.00D 00      0.00D 00      0.90D-02
 102      0.10D 03      0.00D 00      0.00D 00      0.70D-01
 103      0.20D 03      0.00D 00      0.00D 00      0.31D 00
 104      0.30D 03      0.00D 00      0.00D 00      0.74D 00
 105      0.40D 03      0.00D 00      0.00D 00      0.10D 01
 106      0.50D 03      0.00D 00      0.00D 00      0.74D 00
 107      0.60D 03      0.00D 00      0.00D 00      0.31D 00
```

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108   0.700 03   0.000 00   0.000 00   0.700-01
109   0.800 03   0.000 00   0.000 00   0.900-02
110   0.900 03   0.000 00   0.000 00   0.100-02
111   0.000 00   0.200 03   0.000 00   0.000 00
112   0.100 03   0.200 03   0.000 00   0.000 00
113   0.200 03   0.200 03   0.000 00   0.000 00
114   0.300 03   0.200 03   0.000 00   0.000 00
115   0.400 03   0.200 03   0.000 00   0.000 00
116   0.500 03   0.200 03   0.000 00   0.000 00
117   0.600 03   0.200 03   0.000 00   0.000 00
118   0.700 03   0.200 03   0.000 00   0.000 00
119   0.800 03   0.200 03   0.000 00   0.000 00
120   0.900 03   0.200 03   0.000 00   0.000 00
121   0.000 00   0.400 03   0.000 00   0.000 00
122   0.100 03   0.400 03   0.000 00   0.000 00
123   0.200 03   0.400 03   0.000 00   0.000 00
124   0.300 03   0.400 03   0.000 00   0.000 00
125   0.400 03   0.400 03   0.000 00   0.000 00
126   0.500 03   0.400 03   0.000 00   0.000 00
127   0.600 03   0.400 03   0.000 00   0.000 00
128   0.700 03   0.400 03   0.000 00   0.000 00
129   0.800 03   0.400 03   0.000 00   0.000 00
130   0.900 03   0.400 03   0.000 00   0.000 00
131   0.000 00   0.600 03   0.000 00   0.000 00
132   0.100 03   0.600 03   0.000 00   0.000 00
133   0.200 03   0.600 03   0.000 00   0.000 00
134   0.300 03   0.600 03   0.000 00   0.000 00
135   0.400 03   0.600 03   0.000 00   0.000 00
136   0.500 03   0.600 03   0.000 00   0.000 00
137   0.600 03   0.600 03   0.000 00   0.000 00
138   0.700 03   0.600 03   0.000 00   0.000 00
139   0.800 03   0.600 03   0.000 00   0.000 00
140   0.900 03   0.600 03   0.000 00   0.000 00
141   0.000 00   0.800 03   0.000 00   0.000 00
142   0.100 03   0.800 03   0.000 00   0.000 00
143   0.200 03   0.800 03   0.000 00   0.000 00
144   0.300 03   0.800 03   0.000 00   0.000 00
145   0.400 03   0.800 03   0.000 00   0.000 00
146   0.500 03   0.800 03   0.000 00   0.000 00
147   0.600 03   0.800 03   0.000 00   0.000 00
148   0.700 03   0.800 03   0.000 00   0.000 00
149   0.800 03   0.800 03   0.000 00   0.000 00
150   0.900 03   0.800 03   0.000 00   0.000 00
151   0.000 00   0.100 04   0.000 00   0.000 00
152   0.100 03   0.100 04   0.000 00   0.000 00
153   0.200 03   0.100 04   0.000 00   0.000 00
154   0.300 03   0.100 04   0.000 00   0.000 00
155   0.400 03   0.100 04   0.000 00   0.000 00
156   0.500 03   0.100 04   0.000 00   0.000 00
157   0.600 03   0.100 04   0.000 00   0.000 00
158   0.700 03   0.100 04   0.000 00   0.000 00
159   0.800 03   0.100 04   0.000 00   0.000 00
160   0.900 03   0.100 04   0.000 00   0.000 00
161   0.000 00   0.120 04   0.000 00   0.000 00
162   0.100 03   0.120 04   0.000 00   0.000 00
163   0.200 03   0.120 04   0.000 00   0.000 00
164   0.300 03   0.120 04   0.000 00   0.000 00
165   0.400 03   0.120 04   0.000 00   0.000 00
166   0.500 03   0.120 04   0.000 00   0.000 00
167   0.600 03   0.120 04   0.000 00   0.000 00

168   0.700 03   0.120 04   0.000 00   0.000 00
169   0.800 03   0.120 04   0.000 00   0.000 00
170   0.900 03   0.120 04   0.000 00   0.000 00
171   0.000 00   0.140 04   0.000 00   0.000 00
172   0.100 03   0.140 04   0.000 00   0.000 00
173   0.200 03   0.140 04   0.000 00   0.000 00
174   0.300 03   0.140 04   0.000 00   0.000 00
175   0.400 03   0.140 04   0.000 00   0.000 00
176   0.500 03   0.140 04   0.000 00   0.000 00
177   0.600 03   0.140 04   0.000 00   0.000 00
178   0.700 03   0.140 04   0.000 00   0.000 00
179   0.800 03   0.140 04   0.000 00   0.000 00
180   0.900 03   0.140 04   0.000 00   0.000 00
181   0.000 00   0.160 04   0.000 00   0.000 00
182   0.100 03   0.160 04   0.000 00   0.000 00
183   0.200 03   0.160 04   0.000 00   0.000 00
184   0.300 03   0.160 04   0.000 00   0.000 00
185   0.400 03   0.160 04   0.000 00   0.000 00
186   0.500 03   0.160 04   0.000 00   0.000 00
187   0.600 03   0.160 04   0.000 00   0.000 00
188   0.700 03   0.160 04   0.000 00   0.000 00
189   0.800 03   0.160 04   0.000 00   0.000 00
190   0.900 03   0.160 04   0.000 00   0.000 00
191   0.000 00   0.180 04   0.000 00   0.000 00
192   0.100 03   0.180 04   0.000 00   0.000 00
193   0.200 03   0.180 04   0.000 00   0.000 00
194   0.300 03   0.180 04   0.000 00   0.000 00
195   0.400 03   0.180 04   0.000 00   0.000 00
196   0.500 03   0.180 04   0.000 00   0.000 00
197   0.600 03   0.180 04   0.000 00   0.000 00
198   0.700 03   0.180 04   0.000 00   0.000 00
199   0.800 03   0.180 04   0.000 00   0.000 00
200   0.900 03   0.180 04   0.000 00   0.000 00
```

NODE-ELEMENT RELATIONSHIP

ELEMS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	11	12	2	101	111	112	102
2	2	12	13	3	102	112	113	103
3	3	13	14	4	103	113	114	104
4	4	14	15	5	104	114	115	105
5	5	15	16	6	105	115	116	106
6	6	16	17	7	106	116	117	107
7	7	17	18	8	107	117	118	108
8	8	18	19	9	108	118	119	109
9	9	19	20	10	109	119	120	110
10	11	21	22	12	111	121	122	112
11	12	22	23	13	112	122	123	113
12	13	23	24	14	113	123	124	114
13	14	24	25	15	114	124	125	115
14	15	25	26	16	115	125	126	116
15	16	26	27	17	116	126	127	117
16	17	27	28	18	117	127	128	118
17	18	28	29	19	118	128	129	119
18	19	29	30	20	119	129	130	120
19	21	31	32	22	121	131	132	122
20	22	32	33	23	122	132	133	123
21	23	33	34	24	123	133	134	124
22	24	34	35	25	124	134	135	125
23	25	35	36	26	125	135	136	126
24	26	36	37	27	126	136	137	127
25	27	37	38	28	127	137	138	128
26	28	38	39	29	128	138	139	129
27	29	39	40	30	129	139	140	130
28	31	41	42	32	131	141	142	132
29	32	42	43	33	132	142	143	133
30	33	43	44	34	133	143	144	134
31	34	44	45	35	134	144	145	135
32	35	45	46	36	135	145	146	136
33	36	46	47	37	136	146	147	137
34	37	47	48	38	137	147	148	138
35	38	48	49	39	138	148	149	139
36	39	49	50	40	139	149	150	140
37	41	51	52	42	141	151	152	142
38	42	52	53	43	142	152	153	143
39	43	53	54	44	143	153	154	144
40	44	54	55	45	144	154	155	145
41	45	55	56	46	145	155	156	146
42	46	56	57	47	146	156	157	147
43	47	57	58	48	147	157	158	148
44	48	58	59	49	148	158	159	149
45	49	59	61	51	149	159	160	150
46	51	61	62	52	151	161	162	152

47	52	62	63	53	152	162	163	153
48	53	63	64	54	153	163	164	154
49	54	64	65	55	154	164	165	155
50	55	65	66	56	155	165	166	156
51	56	66	67	57	156	166	167	157
52	57	67	68	58	157	167	168	158
53	58	68	69	59	158	168	169	159
54	59	69	70	60	159	169	170	160
55	61	71	72	62	161	171	172	162
56	62	72	73	63	162	172	173	163
57	63	73	74	64	163	173	174	164
58	64	74	75	65	164	174	175	165
59	65	75	76	66	165	175	176	166
60	66	76	77	67	166	176	177	167
61	67	77	78	68	167	177	178	168
62	68	78	79	69	168	178	179	169
63	69	79	80	70	169	179	180	170
64	71	81	82	72	171	181	182	172
65	72	82	83	73	172	182	183	173
66	73	83	84	74	173	183	184	174
67	74	84	85	75	174	184	185	175
68	75	85	86	76	175	185	186	176
69	76	86	87	77	176	186	187	177
70	77	87	88	78	177	187	188	178
71	78	88	89	79	178	188	189	179
72	79	89	90	80	179	189	190	180
73	81	91	92	82	181	191	192	182
74	82	92	93	83	182	192	193	183
75	83	93	94	84	183	193	194	184
76	84	94	95	85	184	194	195	185
77	85	95	96	86	185	195	196	186
78	86	96	97	87	186	196	197	187
79	87	97	98	88	187	197	198	188
80	88	98	99	89	188	198	199	189
81	89	99	100	90	189	199	200	190

```
                              FIXED BOUNDARY CONDITIONS

 NODE      ID        NODE      ID        NODE      ID        NODE      ID        NODE      ID

    1       1           2       1           3       1           4       1           5       1
    6       1           7       1           8       1           9       1          10       1
   11       1          20       0          21       1          20       0          31       1
   40       0          41       1          50       0          51       1          60       0
   61       1          70       0          71       1          80       0          81       1
   90       0         101       0         102       0         103       0         104       0
  105       0         106       0         107       0         108       0         109       0
  110       0         111       0         120       0         121       0         130       0
  131       0         140       0         141       0         150       0         151       0
  160       0         161       0         170       0         171       0         180       0
  181       0         190       0         191       0         192       0         193       0
  194       0         195       0         196       0         197       0         198       0
  199       0         200       0


                         MAXIMUM BANDWIDTH = 112 ON ROW NO  12
```

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                              OUTPUT FOR THREE-DIMENSIONAL
                              ----------------------------
                           GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                           ------------------------------------------

                            INITIAL CONC DISTRIBUTION AT TIME =   0 000  DAYS
NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

    1   0 0000D 00       2   0 0000D 00       3   0 0000D 00       4   0 0000D 00       5   0 0000D 00
    6   0 0000D 00       7   0 0000D 00       8   0.0000D 00       9   0 0000D 00      10   0 0000D 00
   11   0 0000D 00      12   0 0000D 00      13   0 0000D 00      14   0 0000D 00      15   0 0000D 00
   16   0 0000D 00      17   0 0000D 00      18   0.0000D 00      19   0.0000D 00      20   0 0000D 00
   21   0 0000D 00      22   0 0000D 00      23   0 0000D 00      24   0 0000D 00      25   0 0000D 00
   26   0 0000D 00      27   0 0000D 00      28   0 0000D 00      29   0 0000D 00      30   0 0000D 00
   31   0 0000D 00      32   0 0000D 00      33   0 0000D 00      34   0 0000D 00      35   0 0000D 00
   36   0 0000D 00      37   0 0000D 00      38   0 0000D 00      39   0 0000D 00      40   0 0000D 00
   41   0 0000D 00      42   0.0000D 00      43   0 0000D 00      44   0 0000D 00      45   0 0000D 00
   46   0 0000D 00      47   0 0000D 00      48   0 0000D 00      49   0 0000D 00      50   0 0000D 00
   51   0 0000D 00      52   0 0000D 00      53   0 0000D 00      54   0 0000D 00      55   0 0000D 00
   56   0 0000D 00      57   0.0000D 00      58   0 0000D 00      59   0 0000D 00      60   0 0000D 00
   61   0 0000D 00      62   0 0000D 00      63   0 0000D 00      64   0 0000D 00      65   0 0000D 00
   66   0 0000D 00      67   0 0000D 00      68   0 0000D 00      69   0 0000D 00      70   0 0000D 00
   71   0 0000D 00      72   0 0000D 00      73   0 0000D 00      74   0 0000D 00      75   0 0000D 00
   76   0 0000D 00      77   0 0000D 00      78   0.0000D 00      79   0.0000D 00      80   0 0000D 00
   81   0 0000D 00      82   0.0000D 00      83   0 0000D 00      84   0 0000D 00      85   0 0000D 00
   86   0 0000D 00      87   0 0000D 00      88   0 0000D 00      89   0 0000D 00      90   0 0000D 00
   91   0 0000D 00      92   0 0000D 00      93   0.0000D 00      94   0 0000D 00      95   0 0000D 00
   96   0 0000D 00      97   0 0000D 00      98   0 0000D 00      99   0 0000D 00     100   0 0000D 00
  101   0 0000D 00     102   0 0000D 00     103   0 0000D 00     104   0 0000D 00     105   0 0000D 00
  106   0 0000D 00     107   0 0000D 00     108   0 0000D 00     109   0.0000D 00     110   0 0000D 00
  111   0 0000D 00     112   0 0000D 00     113   0 0000D 00     114   0 0000D 00     115   0 0000D 00
  116   0 0000D 00     117   0 0000D 00     118   0 0000D 00     119   0 0000D 00     120   0 0000D 00
  121   0 0000D 00     122   0 0000D 00     123   0 0000D 00     124   0 0000D 00     125   0 0000D 00
  126   0 0000D 00     127   0 0000D 00     128   0.0000D 00     129   0 0000D 00     130   0 0000D 00
  131   0 0000D 00     132   0 0000D 00     133   0 0000D 00     134   0 0000D 00     135   0 0000D 00
  136   0 0000D 00     137   0 0000D 00     138   0 0000D 00     139   0 0000D 00     140   0 0000D 00
  141   0 0000D 00     142   0 0000D 00     143   0 0000D 00     144   0 0000D 00     145   0 0000D 00
  146   0 0000D 00     147   0 0000D 00     148   0 0000D 00     149   0 0000D 00     150   0 0000D 00
  151   0 0000D 00     152   0 0000D 00     153   0 0000D 00     154   0 0000D 00     155   0 0000D 00
  156   0 0000D 00     157   0 0000D 00     158   0 0000D 00     159   0 0000D 00     160   0 0000D 00
  161   0 0000D 00     162   0 0000D 00     163   0 0000D 00     164   0 0000D 00     165   0 0000D 00
  166   0 0000D 00     167   0 0000D 00     168   0 0000D 00     169   0 0000D 00     170   0 0000D 00
  171   0 0000D 00     172   0 0000D 00     173   0 0000D 00     174   0 0000D 00     175   0 0000D 00
  176   0 0000D 00     177   0 0000D 00     178   0 0000D 00     179   0 0000D 00     180   0 0000D 00
  181   0 0000D 00     182   0 0000D 00     183   0.0000D 00     184   0 0000D 00     185   0 0000D 00
  186   0 0000D 00     187   0 0000D 00     188   0.0000D 00     189   0 0000D 00     190   0 0000D 00
  191   0 0000D 00     192   0 0000D 00     193   0 0000D 00     194   0 0000D 00     195   0 0000D 00
  196   0 0000D 00     197   0 0000D 00     198   0 0000D 00     199   0 0000D 00     200   0.0000D 00
```

```
                                    CONC DISTRIBUTION AT TIME = 175.000 DAYS
NODES   CONCS        NODES   CONCS        NODES   CONCS        NODES   CONCS        NODES   CONCS

    1   0.900D-02        2   0.700D-01        3   0.306D 00        4   0.744D 00        5   0.100D 01
    6   0.744D 00        7   0.306D 00        8   0.700D-01        9   0.900D-02       10   0.100D-02
   11   0.100D-02       12   0.220D-01       13   0.192D 00       14   0.532D 00       15   0.907D 00
   16   0.841D 00       17   0.528D 00       18   0.180D 00       19   0.000D 00       20   0.000D 00
   21   0.000D 00       22   0.000D 00       23   0.800D-02       24   0.392D 00       25   0.813D 00
   26   0.984D 00       27   0.811D 00       28   0.403D 00       29   0.120D 00       30   0.000D 00
   31   0.000D 00       32   0.000D 00       33   0.000D 00       34   0.200D 00       35   0.547D 00
   36   0.770D 00       37   0.710D 00       38   0.414D 00       39   0.102D 00       40   0.000D 00
   41   0.000D 00       42   0.000D 00       43   0.000D 00       44   0.000D 00       45   0.167D 00
   46   0.352D 00       47   0.377D 00       48   0.187D 00       49   0.000D 00       50   0.000D 00
   51   0.000D 00       52   0.000D 00       53   0.000D 00       54   0.000D 00       55   0.000D 00
   56   0.000D 00       57   0.000D 00       58   0.000D 00       59   0.000D 00       60   0.000D 00
   61   0.000D 00       62   0.000D 00       63   0.000D 00       64   0.000D 00       65   0.000D 00
   66   0.000D 00       67   0.000D 00       68   0.000D 00       69   0.000D 00       70   0.000D 00
   71   0.000D 00       72   0.000D 00       73   0.000D 00       74   0.000D 00       75   0.000D 00
   76   0.000D 00       77   0.000D 00       78   0.000D 00       79   0.000D 00       80   0.000D 00
   81   0.000D 00       82   0.000D 00       83   0.000D 00       84   0.000D 00       85   0.000D 00
   86   0.000D 00       87   0.000D 00       88   0.000D 00       89   0.000D 00       90   0.000D 00
   91   0.000D 00       92   0.000D 00       93   0.000D 00       94   0.000D 00       95   0.000D 00
   96   0.000D 00       97   0.000D 00       98   0.000D 00       99   0.000D 00      100   0.000D 00
  101   0.900D-02      102   0.700D-01      103   0.306D 00      104   0.744D 00      105   0.100D 01
  106   0.744D 00      107   0.306D 00      108   0.700D-01      109   0.900D-02      110   0.100D-02
  111   0.100D-02      112   0.220D-01      113   0.192D 00      114   0.532D 00      115   0.907D 00
  116   0.841D 00      117   0.528D 00      118   0.180D 00      119   0.000D 00      120   0.000D 00
  121   0.000D 00      122   0.000D 00      123   0.800D-02      124   0.392D 00      125   0.813D 00
  126   0.984D 00      127   0.811D 00      128   0.403D 00      129   0.120D 00      130   0.000D 00
  131   0.000D 00      132   0.000D 00      133   0.000D 00      134   0.200D 00      135   0.547D 00
  136   0.770D 00      137   0.710D 00      138   0.414D 00      139   0.102D 00      140   0.000D 00
  141   0.000D 00      142   0.000D 00      143   0.000D 00      144   0.000D 00      145   0.167D 00
  146   0.352D 00      147   0.377D 00      148   0.187D 00      149   0.000D 00      150   0.000D 00
  151   0.000D 00      152   0.000D 00      153   0.000D 00      154   0.000D 00      155   0.000D 00
  156   0.000D 00      157   0.000D 00      158   0.000D 00      159   0.000D 00      160   0.000D 00
  161   0.000D 00      162   0.000D 00      163   0.000D 00      164   0.000D 00      165   0.000D 00
  166   0.000D 00      167   0.000D 00      168   0.000D 00      169   0.000D 00      170   0.000D 00
  171   0.000D 00      172   0.000D 00      173   0.000D 00      174   0.000D 00      175   0.000D 00
  176   0.000D 00      177   0.000D 00      178   0.000D 00      179   0.000D 00      180   0.000D 00
  181   0.000D 00      182   0.000D 00      183   0.000D 00      184   0.000D 00      185   0.000D 00
  186   0.000D 00      187   0.000D 00      188   0.000D 00      189   0.000D 00      190   0.000D 00
  191   0.000D 00      192   0.000D 00      193   0.000D 00      194   0.000D 00      195   0.000D 00
  196   0.000D 00      197   0.000D 00      198   0.000D 00      199   0.000D 00      200   0.000D 00
```

```
                    INPUT DATA FOR THREE-DIMENSIONAL
                    --------------------------------
                GROUNDWATER DISP BY FINITE ELEMENT METHOD.
                -----------------------------------------

TOTAL NO  OF ELEMENTS               =  81
TOTAL NO  OF NODES                  = 200
MAXIMUM NO  OF NODES PER ELEMENT    =   8
TOTAL NO  OF MATERIALS              =   1
NUMBER OF PUMPING WELLS             =   0
NUMBER OF CONCS TO BE ESTIMATED     = 180



NUMBER OF PUMPING PERIODS           =   0
TOTAL SIMULATION PERIODS            =   7
FACTOR MULTIPLYING COMPUTED CONCS =     1 00000



STEP SIZE                           =  25 00000
STATE OF PROBLEM                    =   1
NO  OF SPECIFIED CONDITIONS         =  62
```

```
               COORDINATES AND INITIAL CONCS OF NODES (L)

NODES     Y(I)         X(I)         Z(I)         CINT(I)

  1     0.000 00     0.000 00     0.100 02     0.800-02
  2     0.100 03     0.000 00     0.100 02     0.700-01
  3     0.200 03     0.000 00     0.100 02     0.310 00
  4     0.300 03     0.000 00     0.100 02     0.740 00
  5     0.400 03     0.000 00     0.100 02     0.100 01
  6     0.500 03     0.000 00     0.100 02     0.740 00
  7     0.600 03     0.000 00     0.100 02     0.310 00
  8     0.700 03     0.000 00     0.100 02     0.700-01
  9     0.800 03     0.000 00     0.100 02     0.800-02
 10     0.900 03     0.000 00     0.100 02     0.100-02
 11     0.000 00     0.200 03     0.100 02     0.000 00
 12     0.100 03     0.200 03     0.100 02     0.000 00
 13     0.200 03     0.200 03     0.100 02     0.000 00
 14     0.300 03     0.200 03     0.100 02     0.000 00
 15     0.400 03     0.200 03     0.100 02     0.000 00
 16     0.500 03     0.200 03     0.100 02     0.000 00
 17     0.600 03     0.200 03     0.100 02     0.000 00
 18     0.700 03     0.200 03     0.100 02     0.000 00
 19     0.800 03     0.200 03     0.100 02     0.000 00
 20     0.900 03     0.200 03     0.100 02     0.000 00
 21     0.000 00     0.400 03     0.100 02     0.000 00
 22     0.100 03     0.400 03     0.100 02     0.000 00
 23     0.200 03     0.400 03     0.100 02     0.000 00
 24     0.300 03     0.400 03     0.100 02     0.000 00
 25     0.400 03     0.400 03     0.100 02     0.000 00
 26     0.500 03     0.400 03     0.100 02     0.000 00
 27     0.600 03     0.400 03     0.100 02     0.000 00
 28     0.700 03     0.400 03     0.100 02     0.000 00
 29     0.800 03     0.400 03     0.100 02     0.000 00
 30     0.900 03     0.400 03     0.100 02     0.000 00
 31     0.000 00     0.600 03     0.100 02     0.000 00
 32     0.100 03     0.600 03     0.100 02     0.000 00
 33     0.200 03     0.600 03     0.100 02     0.000 00
 34     0.300 03     0.600 03     0.100 02     0.000 00
 35     0.400 03     0.600 03     0.100 02     0.000 00
 36     0.500 03     0.600 03     0.100 02     0.000 00
 37     0.600 03     0.600 03     0.100 02     0.000 00
 38     0.700 03     0.600 03     0.100 02     0.000 00
 39     0.800 03     0.600 03     0.100 02     0.000 00
 40     0.900 03     0.600 03     0.100 02     0.000 00
 41     0.000 00     0.800 03     0.100 02     0.000 00
 42     0.100 03     0.800 03     0.100 02     0.000 00
 43     0.200 03     0.800 03     0.100 02     0.000 00
 44     0.300 03     0.800 03     0.100 02     0.000 00
 45     0.400 03     0.800 03     0.100 02     0.000 00
 46     0.500 03     0.800 03     0.100 02     0.000 00
 47     0.600 03     0.800 03     0.100 02     0.000 00

 48     0.700 03     0.800 03     0.100 02     0.000 00
 49     0.800 03     0.800 03     0.100 02     0.000 00
 50     0.900 03     0.800 03     0.100 02     0.000 00
 51     0.000 00     0.100 04     0.100 02     0.000 00
 52     0.100 03     0.100 04     0.100 02     0.000 00
 53     0.200 03     0.100 04     0.100 02     0.000 00
 54     0.300 03     0.100 04     0.100 02     0.000 00
 55     0.400 03     0.100 04     0.100 02     0.000 00
 56     0.500 03     0.100 04     0.100 02     0.000 00
 57     0.600 03     0.100 04     0.100 02     0.000 00
 58     0.700 03     0.100 04     0.100 02     0.000 00
 59     0.800 03     0.100 04     0.100 02     0.000 00
 60     0.900 03     0.100 04     0.100 02     0.000 00
 61     0.000 00     0.120 04     0.100 02     0.000 00
 62     0.100 03     0.120 04     0.100 02     0.000 00
 63     0.200 03     0.120 04     0.100 02     0.000 00
 64     0.300 03     0.120 04     0.100 02     0.000 00
 65     0.400 03     0.120 04     0.100 02     0.000 00
 66     0.500 03     0.120 04     0.100 02     0.000 00
 67     0.600 03     0.120 04     0.100 02     0.000 00
 68     0.700 03     0.120 04     0.100 02     0.000 00
 69     0.800 03     0.120 04     0.100 02     0.000 00
 70     0.900 03     0.120 04     0.100 02     0.000 00
 71     0.000 00     0.140 04     0.100 02     0.000 00
 72     0.100 03     0.140 04     0.100 02     0.000 00
 73     0.200 03     0.140 04     0.100 02     0.000 00
 74     0.300 03     0.140 04     0.100 02     0.000 00
 75     0.400 03     0.140 04     0.100 02     0.000 00
 76     0.500 03     0.140 04     0.100 02     0.000 00
 77     0.600 03     0.140 04     0.100 02     0.000 00
 78     0.700 03     0.140 04     0.100 02     0.000 00
 79     0.800 03     0.140 04     0.100 02     0.000 00
 80     0.900 03     0.140 04     0.100 02     0.000 00
 81     0.000 00     0.160 04     0.100 02     0.000 00
 82     0.100 03     0.160 04     0.100 02     0.000 00
 83     0.200 03     0.160 04     0.100 02     0.000 00
 84     0.300 03     0.160 04     0.100 02     0.000 00
 85     0.400 03     0.160 04     0.100 02     0.000 00
 86     0.500 03     0.160 04     0.100 02     0.000 00
 87     0.600 03     0.160 04     0.100 02     0.000 00
 88     0.700 03     0.160 04     0.100 02     0.000 00
 89     0.800 03     0.160 04     0.100 02     0.000 00
 90     0.900 03     0.160 04     0.100 02     0.000 00
 91     0.000 00     0.180 04     0.100 02     0.000 00
 92     0.100 03     0.180 04     0.100 02     0.000 00
 93     0.200 03     0.180 04     0.100 02     0.000 00
 94     0.300 03     0.180 04     0.100 02     0.000 00
 95     0.400 03     0.180 04     0.100 02     0.000 00
 96     0.500 03     0.180 04     0.100 02     0.000 00
 97     0.600 03     0.180 04     0.100 02     0.000 00
 98     0.700 03     0.180 04     0.100 02     0.000 00
 99     0.800 03     0.180 04     0.100 02     0.000 00
100     0.900 03     0.180 04     0.100 02     0.000 00
101     0.000 00     0.000 00     0.000 00     0.800-02
102     0.100 03     0.000 00     0.000 00     0.700-01
103     0.200 03     0.000 00     0.000 00     0.310 00
104     0.300 03     0.000 00     0.000 00     0.740 00
105     0.400 03     0.000 00     0.000 00     0.100 01
106     0.500 03     0.000 00     0.000 00     0.740 00
107     0.600 03     0.000 00     0.000 00     0.310 00
```

```
108    0.700D 03    0.000D 00    0.000D 00    0.700D-01
109    0.800D 03    0.000D 00    0.000D 00    0.900D-02
110    0.900D 03    0.000D 00    0.000D 00    0.100D-02
111    0.000D 00    0.200D 03    0.000D 00    0.000D 00
112    0.100D 03    0.200D 03    0.000D 00    0.000D 00
113    0.200D 03    0.200D 03    0.000D 00    0.000D 00
114    0.300D 03    0.200D 03    0.000D 00    0.000D 00
115    0.400D 03    0.200D 03    0.000D 00    0.000D 00
116    0.500D 03    0.200D 03    0.000D 00    0.000D 00
117    0.600D 03    0.200D 03    0.000D 00    0.000D 00
118    0.700D 03    0.200D 03    0.000D 00    0.000D 00
119    0.800D 03    0.200D 03    0.000D 00    0.000D 00
120    0.900D 03    0.200D 03    0.000D 00    0.000D 00
121    0.000D 00    0.400D 03    0.000D 00    0.000D 00
122    0.100D 03    0.400D 03    0.000D 00    0.000D 00
123    0.200D 03    0.400D 03    0.000D 00    0.000D 00
124    0.300D 03    0.400D 03    0.000D 00    0.000D 00
125    0.400D 03    0.400D 03    0.000D 00    0.000D 00
126    0.500D 03    0.400D 03    0.000D 00    0.000D 00
127    0.600D 03    0.400D 03    0.000D 00    0.000D 00
128    0.700D 03    0.400D 03    0.000D 00    0.000D 00
129    0.800D 03    0.400D 03    0.000D 00    0.000D 00
130    0.900D 03    0.400D 03    0.000D 00    0.000D 00
131    0.000D 00    0.600D 03    0.000D 00    0.000D 00
132    0.100D 03    0.600D 03    0.000D 00    0.000D 00
133    0.200D 03    0.600D 03    0.000D 00    0.000D 00
134    0.300D 03    0.600D 03    0.000D 00    0.000D 00
135    0.400D 03    0.600D 03    0.000D 00    0.000D 00
136    0.500D 03    0.600D 03    0.000D 00    0.000D 00
137    0.600D 03    0.600D 03    0.000D 00    0.000D 00
138    0.700D 03    0.600D 03    0.000D 00    0.000D 00
139    0.800D 03    0.600D 03    0.000D 00    0.000D 00
140    0.900D 03    0.600D 03    0.000D 00    0.000D 00
141    0.000D 00    0.800D 03    0.000D 00    0.000D 00
142    0.100D 03    0.800D 03    0.000D 00    0.000D 00
143    0.200D 03    0.800D 03    0.000D 00    0.000D 00
144    0.300D 03    0.800D 03    0.000D 00    0.000D 00
145    0.400D 03    0.800D 03    0.000D 00    0.000D 00
146    0.500D 03    0.800D 03    0.000D 00    0.000D 00
147    0.600D 03    0.800D 03    0.000D 00    0.000D 00
148    0.700D 03    0.800D 03    0.000D 00    0.000D 00
149    0.800D 03    0.800D 03    0.000D 00    0.000D 00
150    0.900D 03    0.800D 03    0.000D 00    0.000D 00
151    0.000D 00    0.100D 04    0.000D 00    0.000D 00
152    0.100D 03    0.100D 04    0.000D 00    0.000D 00
153    0.200D 03    0.100D 04    0.000D 00    0.000D 00
154    0.300D 03    0.100D 04    0.000D 00    0.000D 00
155    0.400D 03    0.100D 04    0.000D 00    0.000D 00
156    0.500D 03    0.100D 04    0.000D 00    0.000D 00
157    0.600D 03    0.100D 04    0.000D 00    0.000D 00
158    0.700D 03    0.100D 04    0.000D 00    0.000D 00
159    0.800D 03    0.100D 04    0.000D 00    0.000D 00
160    0.900D 03    0.100D 04    0.000D 00    0.000D 00
161    0.000D 00    0.120D 04    0.000D 00    0.000D 00
162    0.100D 03    0.120D 04    0.000D 00    0.000D 00
163    0.200D 03    0.120D 04    0.000D 00    0.000D 00
164    0.300D 03    0.120D 04    0.000D 00    0.000D 00
165    0.400D 03    0.120D 04    0.000D 00    0.000D 00
166    0.500D 03    0.120D 04    0.000D 00    0.000D 00
167    0.600D 03    0.120D 04    0.000D 00    0.000D 00
```

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168    0.700D 03    0.120D 04    0.000D 00    0.000D 00
169    0.800D 03    0.120D 04    0.000D 00    0.000D 00
170    0.900D 03    0.120D 04    0.000D 00    0.000D 00
171    0.000D 00    0.140D 04    0.000D 00    0.000D 00
172    0.100D 03    0.140D 04    0.000D 00    0.000D 00
173    0.200D 03    0.140D 04    0.000D 00    0.000D 00
174    0.300D 03    0.140D 04    0.000D 00    0.000D 00
175    0.400D 03    0.140D 04    0.000D 00    0.000D 00
176    0.500D 03    0.140D 04    0.000D 00    0.000D 00
177    0.600D 03    0.140D 04    0.000D 00    0.000D 00
178    0.700D 03    0.140D 04    0.000D 00    0.000D 00
179    0.800D 03    0.140D 04    0.000D 00    0.000D 00
180    0.900D 03    0.140D 04    0.000D 00    0.000D 00
181    0.000D 00    0.160D 04    0.000D 00    0.000D 00
182    0.100D 03    0.160D 04    0.000D 00    0.000D 00
183    0.200D 03    0.160D 04    0.000D 00    0.000D 00
184    0.300D 03    0.160D 04    0.000D 00    0.000D 00
185    0.400D 03    0.160D 04    0.000D 00    0.000D 00
186    0.500D 03    0.160D 04    0.000D 00    0.000D 00
187    0.600D 03    0.160D 04    0.000D 00    0.000D 00
188    0.700D 03    0.160D 04    0.000D 00    0.000D 00
189    0.800D 03    0.160D 04    0.000D 00    0.000D 00
190    0.900D 03    0.160D 04    0.000D 00    0.000D 00
191    0.000D 00    0.180D 04    0.000D 00    0.000D 00
192    0.100D 03    0.180D 04    0.000D 00    0.000D 00
193    0.200D 03    0.180D 04    0.000D 00    0.000D 00
194    0.300D 03    0.180D 04    0.000D 00    0.000D 00
195    0.400D 03    0.180D 04    0.000D 00    0.000D 00
196    0.500D 03    0.180D 04    0.000D 00    0.000D 00
197    0.600D 03    0.180D 04    0.000D 00    0.000D 00
198    0.700D 03    0.180D 04    0.000D 00    0.000D 00
199    0.800D 03    0.180D 04    0.000D 00    0.000D 00
200    0.900D 03    0.180D 04    0.000D 00    0.000D 00
```

NODE-ELEMENT RELATIONSHIP

ELEMS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	11	12	2	101	111	112	102
2	2	12	13	3	102	112	113	103
3	3	13	14	4	103	113	114	104
4	4	14	15	5	104	114	115	105
5	5	15	16	6	105	115	116	106
6	6	16	17	7	106	116	117	107
7	7	17	18	8	107	117	118	108
8	8	18	19	9	108	118	119	109
9	9	19	20	10	109	119	120	110
10	11	21	22	12	111	121	122	112
11	12	22	23	13	112	122	123	113
12	13	23	24	14	113	123	124	114
13	14	24	25	15	114	124	125	115
14	15	25	26	16	115	125	126	116
15	16	26	27	17	116	126	127	117
16	17	27	28	18	117	127	128	118
17	18	28	29	19	118	128	129	119
18	19	29	30	20	119	129	130	120
19	21	31	32	22	121	131	132	122
20	22	32	33	23	122	132	133	123
21	23	33	34	24	123	133	134	124
22	24	34	35	25	124	134	135	125
23	25	35	36	26	125	135	136	126
24	26	36	37	27	126	136	137	127
25	27	37	38	28	127	137	138	128
26	28	38	39	29	128	138	139	129
27	29	39	40	30	129	139	140	130
28	31	41	42	32	131	141	142	132
29	32	42	43	33	132	142	143	133
30	33	43	44	34	133	143	144	134
31	34	44	45	35	134	144	145	135
32	35	45	46	36	135	145	146	136
33	36	46	47	37	136	146	147	137
34	37	47	48	38	137	147	148	138
35	38	48	49	39	138	148	149	139
36	39	49	50	40	139	149	150	140
37	41	51	52	42	141	151	152	142
38	42	52	53	43	142	152	153	143
39	43	53	54	44	143	153	154	144
40	44	54	55	45	144	154	155	145
41	45	55	56	46	145	155	156	146
42	46	56	57	47	146	156	157	147
43	47	57	58	48	147	157	158	148
44	48	58	59	49	148	158	159	149
45	49	59	61	51	149	159	160	150
46	51	61	62	52	151	161	162	152

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 47      52      62      63      53     152     162     163     153
 48      53      63      64      54     153     163     164     154
 49      54      64      65      55     154     164     165     155
 50      55      65      66      56     155     165     166     156
 51      56      66      67      57     156     166     167     157
 52      57      67      68      58     157     167     168     158
 53      58      68      69      59     158     168     169     159
 54      59      69      70      60     159     169     170     160
 55      61      71      72      62     161     171     172     162
 56      62      72      73      63     162     172     173     163
 57      63      73      74      64     163     173     174     164
 58      64      74      75      65     164     174     175     165
 59      65      75      76      66     165     175     176     166
 60      66      76      77      67     166     176     177     167
 61      67      77      78      68     167     177     178     168
 62      68      78      79      69     168     178     179     169
 63      69      79      80      70     169     179     180     170
 64      71      81      82      72     171     181     182     172
 65      72      82      83      73     172     182     183     173
 66      73      83      84      74     173     183     184     174
 67      74      84      85      75     174     184     185     175
 68      75      85      86      76     175     185     186     176
 69      76      86      87      77     176     186     187     177
 70      77      87      88      78     177     187     188     178
 71      78      88      89      79     178     188     189     179
 72      79      89      90      80     179     189     190     180
 73      81      91      92      82     181     191     192     182
 74      82      92      93      83     182     192     193     183
 75      83      93      94      84     183     193     194     184
 76      84      94      95      85     184     194     195     185
 77      85      95      96      86     185     195     196     186
 78      86      96      97      87     186     196     197     187
 79      87      97      98      88     187     197     198     188
 80      88      98      99      89     188     198     199     189
 81      89      99     100      90     189     199     200  .  190


                     FIXED BOUNDARY CONDITIONS

 NODE   ' ID      NODE     ID     NODE     ID     NODE     ID     NODE     ID


    1      1         2      1        3      1        4      1        5      1
    6      1         7      1        8      1        9      1       10      1
   11      1        20      0       21      1       20      0       31      1
   40      0        41      1       50      0       51      1       60      0
   61      1        70      0       71      1       80      0       81      1
   90      0       101      0      102      0      103      0      101      0
  105      0       106      0      107      0      108      0      109      0
  110      0       111      0      120      0      121      0      130      0
  131      0       140      0      141      0      150      0      151      0
  160      0       161      0      170      0      171      0      180      0
  181      0       190      0      191      0      192      0      193      0
  194      0       195      0      196      0      197      0      198      0
  199      0       200      0


                 MAXIMUM BANDWIDTH =  112 ON ROW NO   12
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                          OUTPUT FOR THREE-DIMENSIONAL
                          ----------------------------
                      GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                      ------------------------------------------

                        INITIAL CONC DISTRIBUTION AT TIME =   0.000  DAYS

NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS

   1    0.0000D 00       2    0.0000D 00       3    0.0000D 00       4    0.0000D 00       5    0.0000D 00
   6    0.0000D 00       7    0.0000D 00       8    0.0000D 00       9    0.0000D 00      10    0.0000D 00
  11    0.0000D 00      12    0.0000D 00      13    0.0000D 00      14    0.0000D 00      15    0.0000D 00
  16    0.0000D 00      17    0.0000D 00      18    0.0000D 00      19    0.0000D 00      20    0.0000D 00
  21    0.0000D 00      22    0.0000D 00      23    0.0000D 00      24    0.0000D 00      25    0.0000D 00
  26    0.0000D 00      27    0.0000D 00      28    0.0000D 00      29    0.0000D 00      30    0.0000D 00
  31    0.0000D 00      32    0.0000D 00      33    0.0000D 00      34    0.0000D 00      35    0.0000D 00
  36    0.0000D 00      37    0.0000D 00      38    0.0000D 00      39    0.0000D 00      40    0.0000D 00
  41    0.0000D 00      42    0.0000D 00      43    0.0000D 00      44    0.0000D 00      45    0.0000D 00
  46    0.0000D 00      47    0.0000D 00      48    0.0000D 00      49    0.0000D 00      50    0.0000D 00
  51    0.0000D 00      52    0.0000D 00      53    0.0000D 00      54    0.0000D 00      55    0.0000D 00
  56    0.0000D 00      57    0.0000D 00      58    0.0000D 00      59    0.0000D 00      60    0.0000D 00
  61    0.0000D 00      62    0.0000D 00      63    0.0000D 00      64    0.0000D 00      65    0.0000D 00
  66    0.0000D 00      67    0.0000D 00      68    0.0000D 00      69    0.0000D 00      70    0.0000D 00
  71    0.0000D 00      72    0.0000D 00      73    0.0000D 00      74    0.0000D 00      75    0.0000D 00
  76    0.0000D 00      77    0.0000D 00      78    0.0000D 00      79    0.0000D 00      80    0.0000D 00
  81    0.0000D 00      82    0.0000D 00      83    0.0000D 00      84    0.0000D 00      85    0.0000D 00
  86    0.0000D 00      87    0.0000D 00      88    0.0000D 00      89    0.0000D 00      90    0.0000D 00
  91    0.0000D 00      92    0.0000D 00      93    0.0000D 00      94    0.0000D 00      95    0.0000D 00
  96    0.0000D 00      97    0.0000D 00      98    0.0000D 00      99    0.0000D 00     100    0.0000D 00
 101    0.0000D 00     102    0.0000D 00     103    0.0000D 00     104    0.0000D 00     105    0.0000D 00
 106    0.0000D 00     107    0.0000D 00     108    0.0000D 00     109    0.0000D 00     110    0.0000D 00
 111    0.0000D 00     112    0.0000D 00     113    0.0000D 00     114    0.0000D 00     115    0.0000D 00
 116    0.0000D 00     117    0.0000D 00     118    0.0000D 00     119    0.0000D 00     120    0.0000D 00
 121    0.0000D 00     122    0.0000D 00     123    0.0000D 00     124    0.0000D 00     125    0.0000D 00
 126    0.0000D 00     127    0.0000D 00     128    0.0000D 00     129    0.0000D 00     130    0.0000D 00
 131    0.0000D 00     132    0.0000D 00     133    0.0000D 00     134    0.0000D 00     135    0.0000D 00
 136    0.0000D 00     137    0.0000D 00     138    0.0000D 00     139    0.0000D 00     140    0.0000D 00
 141    0.0000D 00     142    0.0000D 00     143    0.0000D 00     144    0.0000D 00     145    0.0000D 00
 146    0.0000D 00     147    0.0000D 00     148    0.0000D 00     149    0.0000D 00     150    0.0000D 00
 151    0.0000D 00     152    0.0000D 00     153    0.0000D 00     154    0.0000D 00     155    0.0000D 00
 156    0.0000D 00     157    0.0000D 00     158    0.0000D 00     159    0.0000D 00     160    0.0000D 00
 161    0.0000D 00     162    0.0000D 00     163    0.0000D 00     164    0.0000D 00     165    0.0000D 00
 166    0.0000D 00     167    0.0000D 00     168    0.0000D 00     169    0.0000D 00     170    0.0000D 00
 171    0.0000D 00     172    0.0000D 00     173    0.0000D 00     174    0.0000D 00     175    0.0000D 00
 176    0.0000D 00     177    0.0000D 00     178    0.0000D 00     179    0.0000D 00     180    0.0000D 00
 181    0.0000D 00     182    0.0000D 00     183    0.0000D 00     184    0.0000D 00     185    0.0000D 00
 186    0.0000D 00     187    0.0000D 00     188    0.0000D 00     189    0.0000D 00     190    0.0000D 00
 191    0.0000D 00     192    0.0000D 00     193    0.0000D 00     194    0.0000D 00     195    0.0000D 00
 196    0.0000D 00     197    0.0000D 00     198    0.0000D 00     199    0.0000D 00     200    0.0000D 00
```

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                                   CONC DISTRIBUTION AT TIME = 175.000 DAYS
 NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

     1   0 900D-02        2   0 700D 01        3   0.306D 00        4   0 744D 00        5   0 100D 01
     6   0 744D 00        7   0 306D 00        8   0 700D-01        9   0 900D-02       10   0 100D-02
    11   0 000D 00       12   0 320D-01       13   0.251D 00       14   0 512D 00       15   0 902D 00
    16   0 850D 00       17   0 510D 00       18   0.195D 00       19   0 700D-02       20   0 000D 00
    21   0 000D 00       22   0 000D 00       23   0 112D 00       24   0 338D 00       25   0 709D 00
    26   0 940D 00       27   0 612D 00       28   0.300D 00       29   0 600D-02       30   0 000D 00
    31   0 000D 00       32   0 000D 00       33   0 100D 00       34   0 205D 00       35   0 482D 00
    36   0 688D 00       37   0 600D 00       38   0 345D 00       39   0 152D 00       40   0 000D 00
    41   0 000D 00       42   0 000D 00       43   0 000D 00       44   0 100D-02       45   0 244D 00
    46   0 365D 00       47   0 381D 00       48   0.200D 00       49   0 800D-02       50   0 000D 00
    51   0 000D 00       52   0 000D 00       53   0 000D 00       54   0 000D 00       55   0 000D 00
    56   0 000D 00       57   0 000D 00       58   0 000D 00       59   0 000D 00       60   0 000D 00
    61   0 000D 00       62   0.000D 00       63   0 000D 00       64   0 000D 00       65   0 000D 00
    66   0 000D 00       67   0 000D 00       68   0.000D 00       69   0 000D 00       70   0 000D 00
    71   0 000D 00       72   0 000D 00       73   0.000D 00       74   0 000D 00       75   0 000D 00
    76   0 000D 00       77   0 000D 00       78   0.000D 00       79   0 000D 00       80   0 000D 00
    81   0 000D 00       82   0.000D 00       83   0 000D 00       84   0 000D 00       85   0 000D 00
    86   0 000D 00       87   0.000D 00       88   0 000D 00       89   0 000D 00       90   0 000D 00
    91   0 000D 00       92   0 000D 00       93   0.000D 00       94   0 000D 00       95   0 000D 00
    96   0 000D 00       97   0 000D 00       98   0 000D 00       99   0 000D 00      100   0 000D 00
   101   0.900D-02      102   0.700D-01      103   0 306D 00      104   0 744D 00      105   0 100D 01
   106   0 744D 00      107   0 306D 00      108   0.700D-01      109   0 900D-02      110   0 100D-02
   111   0 000D 00      112   0 320D-01      113   0 251D 00      114   0 512D 00      115   0 902D 00
   116   0.850D 00      117   0 510D 00      118   0.195D 00      119   0 700D-02      120   0 000D 00
   121   0 000D 00      122   0 000D 00      123   0.112D 00      124   0 338D 00      125   0 709D 00
   126   0 940D 00      127   0 612D 00      128   0.300D 00      129   0 600D-02      130   0 000D 00
   131   0 000D 00      132   0 000D 00      133   0.100D 00      134   0 205D 00      135   0 482D 00
   136   0 688D 00      137   0 600D 00      138   0.345D 00      139   0.152D 00      140   0 000D 00
   141   0 000D 00      142   0.000D 00      143   0 000D 00      144   0 100D-02      145   0 244D 00
   146   0 365D 00      147   0 381D 00      148   0.200D 00      149   0 800D-02      150   0 000D 00
   151   0 000D 00      152   0 000D 00      153   0.000D 00      154   0 000D 00      155   0 000D 00
   156   0 000D 00      157   0 000D 00      158   0 000D 00      159   0 000D 00      160   0 000D 00
   161   0 000D 00      162   0 000D 00      163   0 000D 00      164   0 000D 00      165   0 000D 00
   166   0 000D 00      167   0 000D 00      168   0 000D 00      169   0 000D 00      170   0 000D 00
   171   0 000D 00      172   0 000D 00      173   0 000D 00      174   0 000D 00      175   0 000D 00
   176   0 000D 00      177   0 000D 00      178   0.000D 00      179   0 000D 00      180   0 000D 00
   181   0 000D 00      182   0 000D 00      183   0.000D 00      184   0 000D 00      185   0 000D 00
   186   0 000D 00      187   0 000D 00      188   0 000D 00      189   0 000D 00      190   0 000D 00
   191   0 000D 00      192   0 000D 00      193   0 000D 00      194   0 000D 00      195   0 000D 00
   196   0 000D 00      197   0 000D 00      198   0 000D 00      199   0 000D 00      200   0 000D 00
```

APPENDIX E

INPUT/OUTPUT OF THREE-DIMENSIONAL TESTING

POINT SOURCE

```
                  INPUT DATA FOR THREE-DIMENSIONAL
                  --------------------------------
               GROUNDWATER DISP BY FINITE ELEMENT METHOD
               -----------------------------------------

TOTAL NO  OF ELEMENTS               =  90
TOTAL NO  OF NODES                  = 168
MAXIMUM NO  OF NODES PER ELEMENT    =   8
TOTAL NO  OF MATERIALS              =   1
NUMBER OF PUMPING WELLS             =   0
NUMBER OF CONCS TO BE ESTIMATED     = 168



NUMBER OF PUMPING PERIODS           =   0
TOTAL SIMULATION PERIODS            =  50
FACTOR MULTIPLYING COMPUTED CONCS =     1 00000



STEP SIZE                           =  24 00000
STATE OF PROBLEM                    =   1
NO  OF SPECIFIED CONDITIONS         =  88
```

```
              COORDINATES AND INITIAL CONCS OF NODES (L)

NODES      Y(I)         X(I)         Z(I)         CINT(I)
   1    0.000 00     0.000 00     0.000 00     0.000 00
   2    0.000 00     0.500 01     0.000 00     0.000 00
   3    0.000 00     0.100 02     0.000 00     0.000 00
   4    0.000 00     0.150 02     0.000 00     0.000 00
   5    0.000 00     0.200 02     0.000 00     0.000 00
   6    0.000 00     0.250 02     0.000 00     0.000 00
   7    0.100 02     0.000 00     0.000 00     0.000 00
   8    0.100 02     0.500 01     0.000 00     0.000 00
   9    0.100 02     0.100 02     0.000 00     0.000 00
  10    0.100 02     0.150 02     0.000 00     0.000 00
  11    0.100 02     0.200 02     0.000 00     0.000 00
  12    0.100 02     0.250 02     0.000 00     0.000 00
  13    0.200 02     0.000 00     0.000 00     0.000 00
  14    0.200 02     0.500 01     0.000 00     0.000 00
  15    0.200 02     0.100 02     0.000 00     0.000 00
  16    0.200 02     0.150 02     0.000 00     0.000 00
  17    0.200 02     0.200 02     0.000 00     0.000 00
  18    0.200 02     0.250 02     0.000 00     0.000 00
  19    0.300 02     0.000 00     0.000 00     0.000 00
  20    0.300 02     0.500 01     0.000 00     0.000 00
  21    0.300 02     0.100 02     0.000 00     0.000 00
  22    0.300 02     0.150 02     0.000 00     0.000 00
  23    0.300 02     0.200 02     0.000 00     0.000 00
  24    0.300 02     0.250 02     0.000 00     0.000 00
  25    0.400 02     0.000 00     0.000 00     0.000 00
  26    0.400 02     0.500 01     0.000 00     0.000 00
  27    0.400 02     0.100 02     0.000 00     0.000 00
  28    0.400 02     0.150 02     0.000 00     0.000 00
  29    0.400 02     0.200 02     0.000 00     0.000 00
  30    0.400 02     0.250 02     0.000 00     0.000 00
  31    0.500 02     0.000 00     0.000 00     0.000 00
  32    0.500 02     0.500 01     0.000 00     0.000 00
  33    0.500 02     0.100 02     0.000 00     0.000 00
  34    0.500 02     0.150 02     0.000 00     0.000 00
  35    0.500 02     0.200 02     0.000 00     0.000 00
  36    0.500 02     0.250 02     0.000 00     0.000 00
  37    0.600 02     0.000 00     0.000 00     0.000 00
  38    0.600 02     0.500 01     0.000 00     0.000 00
  39    0.600 02     0.100 02     0.000 00     0.000 00
  40    0.600 02     0.150 02     0.000 00     0.000 00
  41    0.600 02     0.200 02     0.000 00     0.000 00
  42    0.600 02     0.250 02     0.000 00     0.000 00
  43    0.000 00     0.000 00     0.100 01     0.000 00
  44    0.000 00     0.500 01     0.100 01     0.000 00
  45    0.000 00     0.100 02     0.100 01     0.000 00
  46    0.000 00     0.150 02     0.100 01     0.100 13
  47    0.000 00     0.200 02     0.100 01     0.000 00
  48    0.000 00     0.250 02     0.100 01     0.000 00
  49    0.100 02     0.000 00     0.100 01     0.000 00
  50    0.100 02     0.500 01     0.100 01     0.000 00
  51    0.100 02     0.100 02     0.100 01     0.000 00
  52    0.100 02     0.150 02     0.100 01     0.000 00
  53    0.100 02     0.200 02     0.100 01     0.000 00
  54    0.100 02     0.250 02     0.100 01     0.000 00
  55    0.200 02     0.000 00     0.100 01     0.000 00
  56    0.200 02     0.500 01     0.100 01     0.000 00
  57    0.200 02     0.100 02     0.100 01     0.000 00
  58    0.200 02     0.150 02     0.100 01     0.000 00
  59    0.200 02     0.200 02     0.100 01     0.000 00
  60    0.200 02     0.250 02     0.100 01     0.000 00
  61    0.300 02     0.000 00     0.100 01     0.000 00
  62    0.300 02     0.500 01     0.100 01     0.000 00
  63    0.300 02     0.100 02     0.100 01     0.000 00
  64    0.300 02     0.150 02     0.100 01     0.000 00
  65    0.300 02     0.200 02     0.100 01     0.000 00
  66    0.300 02     0.250 02     0.100 01     0.000 00
  67    0.400 02     0.000 00     0.100 01     0.000 00
  68    0.400 02     0.500 01     0.100 01     0.000 00
  69    0.400 02     0.100 02     0.100 01     0.000 00
  70    0.400 02     0.150 02     0.100 01     0.000 00
  71    0.400 02     0.200 02     0.100 01     0.000 00
  72    0.400 02     0.250 02     0.100 01     0.000 00
  73    0.500 02     0.000 00     0.100 01     0.000 00
  74    0.500 02     0.500 01     0.100 01     0.000 00
  75    0.500 02     0.100 02     0.100 01     0.000 00
  76    0.500 02     0.150 02     0.100 01     0.000 00
  77    0.500 02     0.200 02     0.100 01     0.000 00
  78    0.500 02     0.250 02     0.100 01     0.000 00
  79    0.600 02     0.000 00     0.100 01     0.000 00
  80    0.600 02     0.500 01     0.100 01     0.000 00
  81    0.600 02     0.100 02     0.100 01     0.000 00
  82    0.600 02     0.150 02     0.100 01     0.000 00
  83    0.600 02     0.200 02     0.100 01     0.000 00
  84    0.600 02     0.250 02     0.100 01     0.000 00
  85    0.000 00     0.000 00     0.200 01     0.000 00
  86    0.000 00     0.500 01     0.200 01     0.000 00
  87    0.000 00     0.100 02     0.200 01     0.000 00
  88    0.000 00     0.150 02     0.200 01     0.000 00
  89    0.000 00     0.200 02     0.200 01     0.000 00
  90    0.000 00     0.250 02     0.200 01     0.000 00
  91    0.100 02     0.000 00     0.200 01     0.000 00
  92    0.100 02     0.500 01     0.200 01     0.000 00
  93    0.100 02     0.100 02     0.200 01     0.000 00
  94    0.100 02     0.150 02     0.200 01     0.000 00
  95    0.100 02     0.200 02     0.200 01     0.000 00
  96    0.100 02     0.250 02     0.200 01     0.000 00
  97    0.200 02     0.000 00     0.200 01     0.000 00
  98    0.200 02     0.500 01     0.200 01     0.000 00
  99    0.200 02     0.100 02     0.200 01     0.000 00
 100    0.200 02     0.150 02     0.200 01     0.000 00
 101    0.200 02     0.200 02     0.200 01     0.000 00
 102    0.200 02     0.250 02     0.200 01     0.000 00
 103    0.300 02     0.000 00     0.200 01     0.000 00
 104    0.300 02     0.500 01     0.200 01     0.000 00
 105    0.300 02     0.100 02     0.200 01     0.000 00
 106    0.300 02     0.150 02     0.200 01     0.000 00
 107    0.300 02     0.200 02     0.200 01     0.000 00
```

```
108   0 300 02   0 250 02   0 200 01   0.000 00        168   0 600 02   0 250 02   0 400 01   0 000 00
109   0 400 02   0 000 00   0 200 01   0.000 00
110   0 400 02   0.500 01   0.200 01   0 000 00
111   0 400 02   0.100 02   0.200 01   0.000 00
112   0 400 02   0.150 02   0.200 01   0.000 00
113   0 400 02   0.200 02   0.200 01   0.000 00
114   0 400 02   0.250 02   0.200 01   0.000 00
115   0.500 02   0.000 00   0.200 01   0.000 00
116   0 500 02   0.500 01   0.200 01   0.000 00
117   0 500 02   0.100 02   0.200 01   0.000 00
118   0 500 02   0.150 02   0.200 01   0.000 00
119   0.500 02   0.200 02   0.200 01   0.000 00
120   0.500 02   0.250 02   0.200 01   0.000 00
121   0 600 02   0.000 00   0.200 01   0.000 00
122   0 600 02   0.500 01   0.200 01   0.000 00
123   0 600 02   0.100 02   0.200 01   0.000 00
124   0 600 02   0 150 02   0.200 01   0.000 00
125   0 600 02   0.200 02   0.200 01   0.000 00
126   0 600 02   0.250 02   0.200 01   0.000 00
127   0 000 00   0 000 00   0.400 01   0.000 00
128   0.000 00   0.500 01   0.400 01   0.000 00
129   0 000 00   0.100 02   0.400 01   0.000 00
130   0.000 00   0.150 02   0.400 01   0.000 00
131   0 000 00   0.200 02   0.400 01   0.000 00
132   0 000 00   0.250 02   0.400 01   0.000 00
133   0 100 02   0.000 00   0.400 01   0.000 00
134   0 100 02   0 500 01   0 400 01   0 000 00
135   0.100 02   0.100 02   0.400 01   0.000 00
136   0 100 02   0.150 02   0 400 01   0.000 00
137   0.100 02   0 200 02   0 400 01   0.000 00
138   0 100 02   0.250 02   0.400 01   0.000 00
139   0.200 02   0 000 00   0.400 01   0.000 00
140   0.200 02   0.500 01   0.400 01   0.000 00
141   0.200 02   0.100 02   0.400 01   0.000 00
142   0 200 02   0.150 02   0.400 01   0 000 00
143   0 200 02   0.200 02   0.400 01   0.000 00
144   0 200 02   0.250 02   0.400 01   0 000 00
145   0 300 02   0 000 00   0.400 01   0 000 00
146   0 300 02   0 500 01   0.400 01   0 000 00
147   0.300 02   0 100 02   0.400 01   0 000 00
148   0 300 02   0 150 02   0 400 01   0 000 00
149   0.300 02   0.200 02   0.400 01   0.000 00
150   0 300 02   0 250 02   0.400 01   0 000 00
151   0 400 02   0 000 00   0 400 01   0 000 00
152   0 400 02   0 500 01   0 400 01   0 000 00
153   0 400 02   0 100 02   0 400 01   0 000 00
154   0 400 02   0 150 02   0.400 01   0 000 00
155   0 400 02   0 200 02   0 400 01   0 000 00
156   0 400 02   0.250 02   0.400 01   0 000 00
157   0 500 02   0 000 00   0.400 01   0 000 00
158   0 500 02   0.500 01   0 400 01   0 000 00
159   0 500 02   0 100 02   0 400 01   0.000 00
160   0 500 02   0 150 02   0 400 01   0 000 00
161   0 500 02   0 200 02   0 400 01   0 000 00
162   0 500 02   0.250 02   0 400 01   0.000 00
163   0 600 02   0 000 00   0 400 01   0.000 00
164   0 600 02   0 500 01   0.400 01   0 000 00
165   0 600 02   0 100 02   0 400 01   0 000 00
166   0 600 02   0 150 02   0 400 01   0 000 00
167   0 600 02   0 200 02   0 400 01   0.000 00
```

NODE-ELEMENT RELATIONSHIP

ELENS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	2	8	7	43	44	50	49
2	2	3	9	18	44	45	51	50
3	3	4	10	19	45	46	52	51
4	4	5	11	20	46	47	53	52
5	5	6	12	21	47	48	54	53
6	7	8	14	13	49	50	56	55
7	8	9	15	14	50	51	57	56
8	9	10	16	15	51	52	58	57
9	10	11	17	16	52	53	59	58
10	11	12	18	17	53	54	60	59
11	13	14	20	19	55	56	62	61
12	14	15	21	20	56	57	63	62
13	15	16	22	21	57	58	64	63
14	16	17	23	22	58	59	65	64
15	17	18	24	23	59	60	66	65
16	19	20	26	25	61	62	68	67
17	20	21	27	26	62	63	69	68
18	21	22	28	27	63	64	70	69
19	22	23	29	28	64	65	71	70
20	23	24	30	29	65	66	72	71
21	25	26	32	31	67	68	74	73
22	26	27	33	32	68	69	75	74
23	27	28	34	33	69	70	76	75
24	28	29	35	34	70	71	77	76
25	29	30	36	35	71	72	78	77
26	31	32	38	37	73	74	80	79
27	32	33	39	38	74	75	81	80
28	33	34	40	39	75	76	82	81
29	34	35	41	40	76	77	83	82
30	35	36	42	41	77	78	84	83
31	43	44	50	49	85	86	92	91
32	44	45	51	50	86	87	93	92
33	45	46	52	51	87	88	94	93
34	46	47	53	52	88	89	95	94
35	47	48	54	53	89	90	96	95
36	49	50	56	55	91	92	98	97
37	50	51	57	56	92	93	99	98
38	51	52	58	57	93	94	100	99
39	52	53	59	58	94	95	101	100
40	53	54	60	59	95	96	102	101
41	55	56	62	61	97	98	104	103
42	56	57	63	62	98	99	105	104
43	57	58	64	63	99	100	106	105
44	58	59	65	64	100	101	107	106
45	59	60	66	65	101	102	108	107
46	61	62	68	67	103	104	110	109

47	62	63	69	68	104	105	111	110
48	63	64	70	69	105	106	112	111
49	64	65	71	70	106	107	113	112
50	65	66	72	71	107	108	114	113
51	67	68	74	73	109	110	116	115
52	68	69	75	74	110	111	117	116
53	69	70	76	75	111	112	118	117
54	70	71	77	76	112	113	119	118
55	71	72	78	77	113	114	120	119
56	73	74	80	79	115	116	122	121
57	74	75	81	80	116	117	123	122
58	75	76	82	81	117	118	124	123
59	76	77	83	82	118	119	125	124
60	77	78	84	83	119	120	126	125
61	85	86	92	91	127	128	134	133
62	86	87	93	92	128	129	135	134
63	87	88	94	93	129	130	136	135
64	88	89	95	94	130	131	137	136
65	89	90	96	95	131	132	138	137
66	91	92	98	97	133	134	140	139
67	92	93	99	98	134	135	141	140
68	93	94	100	99	135	136	142	141
69	94	95	101	100	136	137	143	142
70	95	96	102	101	137	138	144	143
71	97	98	104	103	139	140	146	145
72	98	99	105	104	140	141	147	146
73	99	100	106	105	141	142	148	147
74	100	101	107	106	142	143	149	148
75	101	102	108	107	143	144	150	149
76	103	104	110	109	145	146	152	151
77	104	105	111	110	146	147	153	152
78	105	106	112	111	147	148	154	153
79	106	107	113	112	148	149	155	154
80	107	108	114	113	149	150	156	155
81	109	110	116	115	151	152	158	157
82	110	111	117	116	152	153	159	158
83	111	112	118	117	153	154	160	159
84	112	113	119	118	154	155	161	160
85	113	114	120	119	155	156	162	161
86	115	116	122	121	157	158	164	163
87	116	117	123	122	158	159	165	164
88	117	118	124	123	159	160	166	165
89	118	119	125	124	160	161	167	166
90	119	120	126	125	161	162	168	167

```
                                   FIXED BOUNDARY CONDITIONS

   NODE        ID        NODE        ID        NODE        ID        NODE        ID        NODE        ID

      1         0           2         0           3         0           4         0           5         0
      6         0           7         0          12         0          13         0          18         0
     19         0          24         0          25         0          30         0          31         0
     36         0          37         0          38         0          39         0          40         0
     41         0          42         0          43         0          44         0          45         0
     46         0          47         0          48         0          49         0          54         0
     55         0          60         0          61         0          66         0          67         0
     72         0          73         0          78         0          79         0          80         0
     81         0          82         0          83         0          84         0          85         0
     86         0          87         0          88         0          89         0          90         0
     91         0          96         0          97         0         102         0         103         0
    108         0         109         0         114         0         115         0         120         0
    121         0         122         0         123         0         124         0         125         0
    126         0         127         0         128         0         129         0         130         0
    131         0         132         0         133         0         138         0         139         0
    144         0         145         0         150         0         151         0         156         0
    157         0         162         0         163         0         164         0         165         0
    166         0         167         0         168         0

                              MAXIMUM BANDWIDTH =  53 ON ROW NO. 23
```

```
                     CONCENTRATION DISTRIBUTION AT TIME = 720.000 HOURS
NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS      NODES     CONCS

   1   0.443D 00       2   0.626D 03       3   0.830D 05       4   0.626D 03       5   0.661D 00
   6   0.194D 00       7   0.235D 00       8   0.379D 03       9   0.480D 05      10   0.378D 03
  11   0.349D 00      12   0.890D-01      13   0.248D-01      14   0.556D 02      15   0.507D 03
  16   0.556D 02      17   0.374D-01      18   0.890D-02      19   0.617D-05      20   0.214D 01
  21   0.124D 03      22   0.214D 01      23   0.827D-03      24   0.208D-03      25   0.454D-05
  26   0.202D-01      27   0.841D 00      28   0.202D-01      29   0.692D-05      30   0.113D-05
  31   0.103D-07      32   0.512D-04      33   0.167D-02      34   0.512D-04      35   0.159D-07
  36   0.173D-08      37   0.729D-11      38   0.346D-07      39   0.873D-06      40   0.346D-07
  41   0.110D-10      42   0.783D-12      43   0.467D 00      44   0.580D 03      45   0.129D 06
  46   0.580D 03      47   0.624D 00      48   0.264D 00      49   0.243D 00      50   0.343D 03
  51   0.642D 05      52   0.343D 03      53   0.327D 00      54   0.131D 00      55   0.245D-01
  56   0.503D 02      57   0.594D 04      58   0.503D 02      59   0.348D-01      60   0.116D-01
  61   0.581D-03      62   0.186D 01      63   0.160D 03      64   0.186D 01      65   0.849D-03
  66   0.213D-03      67   0.413D-05      68   0.182D-01      69   0.781D 00      70   0.182D-01
  71   0.622D-05      72   0.106D-05      73   0.832D-08      74   0.459D-04      75   0.151D-02
  76   0.459D-04      77   0.143D-07      78   0.155D-08      79   0.664D-11      80   0.314D-09
  81   0.876D-06      82   0.314D-09      83   0.100D-10      84   0.703D-12      85   0.246D 00
  86   0.429D 03      87   0.544D 05      88   0.429D 03      89   0.365D 00      90   0.105D 00
  91   0.131D 00      92   0.248D 03      93   0.285D 05      94   0.248D 03      95   0.193D 00
  96   0.538D-01      97   0.142D-01      98   0.367D 02      99   0.306D 04     100   0.367D 02
 101   0.213D-01     102   0.544D-02     103   0.379D-03     104   0.137D 01     105   0.769D 02
 106   0.137D 01     107   0.570D-03     108   0.122D-03     109   0.291D-05     110   0.134D-01
 111   0.537D 00     112   0.134D-01     113   0.444D-05     114   0.685D-06     115   0.693D-08
 116   0.343D-04     117   0.110D-02     118   0.343D-04     119   0.107D-07     120   0.109D-08
 121   0.498D-11     122   0.233D-07     123   0.645D-06     124   0.233D-07     125   0.748D-11
 126   0.517D-12     127   0.276D-01     128   0.109D 03     129   0.884D 04     130   0.109D 03
 131   0.399D-01     132   0.806D-02     133   0.159D-01     134   0.654D 02     135   0.333D 04
 136   0.654D 02     137   0.231D-01     138   0.506D-02     139   0.220D-02     140   0.960D 01
 141   0.445D 03     142   0.960D 01     143   0.323D-02     144   0.631D-03     145   0.778D-04
 146   0.374D 00     147   0.146D 02     148   0.374D 00     149   0.117D-03     150   0.185D-04
 151   0.744D-06     152   0.379D-02     153   0.125D 00     154   0.379D-02     155   0.115D-05
 156   0.132D-06     157   0.201D-08     158   0.990D-05     159   0.290D-03     160   0.990D-05
 161   0.310D-08     162   0.251D-09     163   0.153D-11     164   0.688D-08     165   0.182D-06
 166   0.689D-08     167   0.225D-11     168   0.134D-12
```

```
                         CONCENTRATION DISTRIBUTION AT TIME = 960.000 HOURS
NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS       NODES     CONCS
    1   0 374D 00        2   0 502D 03        3   0.108D 05        4   0.502D 03        5   0 513D 00
    6   0 163D 00        7   0 252D 00        8   0.394D 03        9   0.518D 05       10   0.394D 03
   11   0 376D 00       12   0 108D 00       13   0.510D-01       14   0.990D 02       15   0 111D 05
   16   0 990D 02       17   0 804D-01       18   0.222D-01       19   0.375D-02       20   0.935D 01
   21   0 777D 03       22   0 835D 01       23   0.561D-02       24   0.145D-02       25   0.940D-04
   26   0 303D 00       27   0 192D 02       28   0.303D 00       29   0.142D-03       30   0.320D-04
   31   0.887D-06       32   0 363D-02       33   0.174D 00       34   0.363D-02       35   0.134D-05
   36   0 248D-06       37   0.337D-08       38   0.159D-04       39   0.605D-03       40   0.605D-03
   41   0 517D-08       42   0 720D-09       43   0.394D 00       44   0.502D 03       45   0.108D 06
   46   0 502D 03       47   0.513D 00       48   0.222D 00       49   0.263D 00       50   0.356D 03
   51   0 702D 05       52   0 356D 03       53   0.353D 00       54   0.144D 00       55   0.542D-01
   56   0 904D 02       57   0 139D 05       58   0.904D 02       59   0.754D-01       60   0.279D-01
   61   0 365D-02       62   0 819D 01       63   0.887D 03       64   0.819D 01       65   0.515D-02
   66   0 165D-02       67   0.888D-04       68   0.275D 00       69   0.198D 02       70   0.275D 00
   71   0 129D-03       72   0.336D-04       73   0 811D-06       74   0.325D-02       75   0.164D 00
   76   0 325D-02       77   0.121D-05       78   0.238D-06       79   0.306D-08       80   0 144D-04
   81   0 550D-03       82   0 144D-04       83   0.470D-08       84   0.657D-09       85   0 209D 00
   86   0 361D 03       87   0 460D 05       88   0.361D 03       89   0.308D 00       90   0.886D-01
   91   0 140D 00       92   0.258D 03       93   0.306D 05       94   0.258D 03       95   0 207D 00
   96   0 582D-01       97   0 303D-01       98   0.656D 02       99   0.656D 04      100   0 656D 02
  101   0 450D-01      102   0 122D-01      103   0.218D-02      104   0.596D 01      105   0 461D 03
  106   0 596D 01      107   0.326D-02      108   0 814D-03      109   0.568D-04      110   0.200D 00
  111   0 110D 02      112   0 200D 00      113   0 852D-04      114   0.184D-04      115   0 563D-06
  116   0 241D-02      117   0.108D 00      118   0.241D-02      119   0.852D-06      120   0 148D-06
  121   0 222D-08      122   0 106D-04      123   0 386D-03      124   0.106D-04      125   0 341D-08
  126   0 444D-09      127   0 237D-01      128   0.950D 02      129   0.503D 04      130   0.950D 02
  131   0 345D-01      132   0 774D-02      133   0.167D-01      134   0.678D 02      135   0.349D 04
  136   0 167D-01      137   0 242D-01      138   0.534D-02      139   0 408D-02      140   0.174D 02
  141   0 842D 03      142   0 408D-02      143   0 595D-02      144   0.125D-02      145   0.355D-03
  146   0 160D 01      147   0 703D 02      148   0.355D-03      149   0 524D-03      150   0 980D-04
  151   0 113D-04      152   0 549D-01      153   0.213D 01      154   0 549D-01      155   0 170D-04
  156   0 269D-05      157   0 134D-06      158   0 675D-03      159   0 235D-01      160   0 675D-03
  161   0 206D-06      162   0 260D-07      163   0 603D-09      164   0.303D-05      165   0 949D-04
  166   0 303D-05      167   0 931D-09      168   0 917D-10
```

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                         CONCENTRATION DISTRIBUTION AT TIME =1200.000 HOURS
NODES     CONCS     NODES     CONCS     NODES     CONCS  .  NODES     CONCS     NODES     CONCS

    1   0 330D 00      2   0 484D 03      3   0.687D 05      4   0.484D 03      5   0 494D 00
    6   0 144D 00      7   0.254D 00      8   0.392D 03      9   0.523D 05     10   0.392D 03
   11   0.379D 00     12   0 109D 00     13   0.798D-01     14   0.138D 03     15   0.165D 05
   16   0 138D 03     17   0 120D 00     18   0.340D-01     19   0.103D-01     20   0.216D 02
   21   0.215D 04     22   0.216D 02     23   0.184D-01     24   0 416D-02     25   0.578D-03
   26   0.147D 01     27   0.122D 03     28   0.147D 01     29   0.868D-03     30   0.218D-03
   31   0.141D-04     32   0 451D-01     33   0.298D 01     34   0 451D-01     35   0.211D-04
   36   0 483D-05     37   0.158D-06     38   0.610D-03     39   0.318D-01     40   0 610D-03
   41   0 238D-06     42   0 468D-07     43   0.347D 00     44   0.448D 03     45   0.950D 05
   46   0 448D 03     47   0 464D 00     48   0.194D 00     49   0.266D 00     50   0.353D 03
   51   0.707D 05     52   0 453D 03     53   0.356D 00     54   0.146D 00     55   0.815D-01
   56   0.125D 03     57   0 212D 05     58   0.125D 03     59   0.112D 00     60   0 434D-01
   61   0.103D-01     62   0 195D 02     63   0.251D 04     64   0.195D 02     65   0 144D-01
   66   0.510D-02     67   0 580D-03     68   0.133D 01     69   0.136D 03     70   0.133D 01
   71   0 804D-03     72   0 219D-03     73   0.141D-04     74   0.405D-01     75   0 304D 01
   76   0 405D-01     77   0.194D-04     78   0.484D-05     79   0.158D-06     80   0.551D-03
   81   0 307D-01     82   0 551D-03     83   0.217D-06     84   0 468D-07     85   0.185D 00
   86   0.321D 03     87   0 409D 05     88   0.321D 03     89   0.273D 00     90   0.783D-01
   91   0 142D 00     92   0 257D 03     93   0.309D 05     94   0.257D 03     95   0.209D 00
   96   0 588D-01     97   0 445D-01     98   0 896D 02     99   0.970D 00    100   0 896D 02
  101   0 660D-01    102   0 181D-01    103   0.587D-02    104   0.210D 00    105   0 125D 04
  106   0 210D 00    107   0 875D-02    108   0.231D-02    109   0.338D-03    110   0.863D 00
  111   0 716D 02    112   0 963D 00    113   0.505D-03    114   0.123D-03    115   0.857D-05
  116   0 129D-04    117   0 177D 01    118   0.129D-04    119   0.128D-04    120   0 279D-05
  121   0 990D-07    122   0 403D-03    123   0 195D-01    124   0 403D-03    125   0 150D-06
  126   0 276D-07    127   0 210D-01    128   0.850D 02    129   0.447D 04    130   0 850D 02
  131   0 300D-01    132   0 689D-02    133   0.166D-01    134   0.348D 02    135   0 671D 02
  136   0 348D 02    137   0 240D-01    138   0.533D-02    139   0.564D-02    140   0.236D 02
  141   0 119D 04    142   0 236D 02    143   0.820D-01    144   0.176D-02    145   0.849D-03
  146   0.365D 01    147   0 171D 03    148   0.365D 01    149   0.124D-02    150   0 251D-03
  151   0 567D-04    152   0 261D 00    153   0.111D 02    154   0 261D 00    155   0 838D-04
  156   0 152D-04    157   0 168D-05    158   0 813D-02    159   0 319D 00    160   0 813D-02
  161   0.253D-05    162   0 402D-06    163   0.226D-07    164   0.112D-03    165   0 404D-02
  166   0 112D-03    167   0 344D-07    168   0 462D-08
```

LINE SOURCES

```
                  INPUT DATA FOR THREE-DIMENSIONAL
                  --------------------------------
              *GROUNDWATER DISP BY FINITE ELEMENT METHOD
              *-----------------------------------------

TOTAL NO  OF ELEMENTS                =   90
TOTAL NO  OF NODES                   =  168
MAXIMUM NO  OF NODES PER ELEMENT     =    8
TOTAL NO  OF MATERIALS               =    1
NUMBER OF PUMPING WELLS              =    0
NUMBER OF CONCS TO BE ESTIMATED      =  168



NUMBER OF PUMPING PERIODS            =    0
TOTAL SIMULATION PERIODS             =   50
FACTOR MULTIPLYING COMPUTED CONCS    =    1 00000



STEP SIZE                            =   24 00000
STATE OF PROBLEM                     =    1
NO  OF SPECIFIED CONDITIONS          =   88
```

```
            COORDINATES AND INITIAL CONCS OF NODES (L)

NODES      Y(I)          X(I)          Z(I)          CINT(I)

    1    0.000 00      0.000 00      0.000 00      0.100 13
    2    0.000 00      0.500 01      0.000 00      0.100 13
    3    0.000 00      0.100 02      0.000 00      0.100 13
    4    0.000 00      0.150 02      0.000 00      0.100 13
    5    0.000 00      0.200 02      0.000 00      0.100 13
    6    0.000 00      0.250 02      0.000 00      0.100 13
    7    0.100 02      0.000 00      0.000 00      0.000 00
    8    0.100 02      0.500 01      0.000 00      0.000 00
    9    0.100 02      0.100 02      0.000 00      0.000 00
   10    0.100 02      0.150 02      0.000 00      0.000 00
   11    0.100 02      0.200 02      0.000 00      0.000 00
   12    0.100 02      0.250 02      0.000 00      0.000 00
   13    0.200 02      0.000 00      0.000 00      0.000 00
   14    0.200 02      0.500 01      0.000 00      0.000 00
   15    0.200 02      0.100 02      0.000 00      0.000 00
   16    0.200 02      0.150 02      0.000 00      0.000 00
   17    0.200 02      0.200 02      0.000 00      0.000 00
   18    0.200 02      0.250 02      0.000 00      0.000 00
   19    0.300 02      0.000 00      0.000 00      0.000 00
   20    0.300 02      0.500 01      0.000 00      0.000 00
   21    0.300 02      0.100 02      0.000 00      0.000 00
   22    0.300 02      0.150 02      0.000 00      0.000 00
   23    0.300 02      0.200 02      0.000 00      0.000 00
   24    0.300 02      0.250 02      0.000 00      0.000 00
   25    0.400 02      0.000 00      0.000 00      0.000 00
   26    0.400 02      0.500 01      0.000 00      0.000 00
   27    0.400 02      0.100 02      0.000 00      0.000 00
   28    0.400 02      0.150 02      0.000 00      0.000 00
   29    0.400 02      0.200 02      0.000 00      0.000 00
   30    0.400 02      0.250 02      0.000 00      0.000 00
   31    0.500 02      0.000 00      0.000 00      0.000 00
   32    0.500 02      0.500 01      0.000 00      0.000 00
   33    0.500 02      0.100 02      0.000 00      0.000 00
   34    0.500 02      0.150 02      0.000 00      0.000 00
   35    0.500 02      0.200 02      0.000 00      0.000 00
   36    0.500 02      0.250 02      0.000 00      0.000 00
   37    0.600 02      0.000 00      0.000 00      0.000 00
   38    0.600 02      0.500 01      0.000 00      0.000 00
   39    0.600 02      0.100 02      0.000 00      0.000 00
   40    0.600 02      0.150 02      0.000 00      0.000 00
   41    0.600 02      0.200 02      0.000 00      0.000 00
   42    0.600 02      0.250 02      0.000 00      0.000 00
   43    0.000 00      0.000 00      0.100 01      0.100 13
   44    0.000 00      0.500 01      0.100 01      0.100 13
   45    0.000 00      0.100 02      0.100 01      0.100 13
   46    0.000 00      0.150 02      0.100 01      0.100 13
   47    0.000 00      0.200 02      0.100 01      0.100 13

   48    0.000 00      0.250 02      0.100 01      0.100 13
   49    0.100 02      0.000 00      0.100 01      0.000 00
   50    0.100 02      0.500 01      0.100 01      0.000 00
   51    0.100 02      0.100 02      0.100 01      0.000 00
   52    0.100 02      0.150 02      0.100 01      0.000 00
   53    0.100 02      0.200 02      0.100 01      0.000 00
   54    0.100 02      0.250 02      0.100 01      0.000 00
   55    0.200 02      0.000 00      0.100 01      0.000 00
   56    0.200 02      0.500 01      0.100 01      0.000 00
   57    0.200 02      0.100 02      0.100 01      0.000 00
   58    0.200 02      0.150 02      0.100 01      0.000 00
   59    0.200 02      0.200 02      0.100 01      0.000 00
   60    0.200 02      0.250 02      0.100 01      0.000 00
   61    0.300 02      0.000 00      0.100 01      0.000 00
   62    0.300 02      0.500 01      0.100 01      0.000 00
   63    0.300 02      0.100 02      0.100 01      0.000 00
   64    0.300 02      0.150 02      0.100 01      0.000 00
   65    0.300 02      0.200 02      0.100 01      0.000 00
   66    0.300 02      0.250 02      0.100 01      0.000 00
   67    0.400 02      0.000 00      0.100 01      0.000 00
   68    0.400 02      0.500 01      0.100 01      0.000 00
   69    0.400 02      0.100 02      0.100 01      0.000 00
   70    0.400 02      0.150 02      0.100 01      0.000 00
   71    0.400 02      0.200 02      0.100 01      0.000 00
   72    0.400 02      0.250 02      0.100 01      0.000 00
   73    0.500 02      0.000 00      0.100 01      0.000 00
   74    0.500 02      0.500 01      0.100 01      0.000 00
   75    0.500 02      0.100 02      0.100 01      0.000 00
   76    0.500 02      0.150 02      0.100 01      0.000 00
   77    0.500 02      0.200 02      0.100 01      0.000 00
   78    0.500 02      0.250 02      0.100 01      0.000 00
   79    0.600 02      0.000 00      0.100 01      0.000 00
   80    0.600 02      0.500 01      0.100 01      0.000 00
   81    0.600 02      0.100 02      0.100 01      0.000 00
   82    0.600 02      0.150 02      0.100 01      0.000 00
   83    0.600 02      0.200 02      0.100 01      0.000 00
   84    0.600 02      0.250 02      0.100 01      0.000 00
   85    0.000 00      0.000 00      0.200 01      0.000 00
   86    0.000 00      0.500 01      0.200 01      0.000 00
   87    0.000 00      0.100 02      0.200 01      0.000 00
   88    0.000 00      0.150 02      0.200 01      0.000 00
   89    0.000 00      0.200 02      0.200 01      0.000 00
   90    0.000 00      0.250 02      0.200 01      0.000 00
   91    0.100 02      0.000 00      0.200 01      0.000 00
   92    0.100 02      0.500 01      0.200 01      0.000 00
   93    0.100 02      0.100 02      0.200 01      0.000 00
   94    0.100 02      0.150 02      0.200 01      0.000 00
   95    0.100 02      0.200 02      0.200 01      0.000 00
   96    0.100 02      0.250 02      0.200 01      0.000 00
   97    0.200 02      0.000 00      0.200 01      0.000 00
   98    0.200 02      0.500 01      0.200 01      0.000 00
   99    0.200 02      0.100 02      0.200 01      0.000 00
  100    0.200 02      0.150 02      0.200 01      0.000 00
  101    0.200 02      0.200 02      0.200 01      0.000 00
  102    0.200 02      0.250 02      0.200 01      0.000 00
  103    0.300 02      0.000 00      0.200 01      0.000 00
  104    0.300 02      0.500 01      0.200 01      0.000 00
  105    0.300 02      0.100 02      0.200 01      0.000 00
  106    0.300 02      0.150 02      0.200 01      0.000 00
  107    0.300 02      0.200 02      0.200 01      0.000 00
```

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108     0 30D 02     0.25D 02     0 20D 01     0 00D 00
109     0 40D 02     0 00D 00     0.20D 01     0.00D 00
110     0.40D 02     0 50D 01     0.20D 01     0.00D 00
111     0 40D 02     0.10D 02     0.20D 01     0 00D 00
112     0.40D 02     0.15D 02     0.20D 01     0.00D 00
113     0 40D 02     0.20D 02     0.20D 01     0.00D 00
114     0.40D 02     0.25D 02     0.20D 01     0.00D 00
115     0 50D 02     0.00D 00     0.20D 01     0.00D 00
116     0.50D 02     0.50D 01     0.20D 01     0.00D 00
117     0 50D 02     0.10D 02     0.20D 01     0.00D 00
118     0 50D 02     0.15D 02     0.20D 01     0.00D 00
119     0 50D 02     0.20D 02     0.20D 01     0.00D 00
120     0.50D 02     0.25D 02     0.20D 01     0 00D 00
121     0.60D 02     0.00D 00     0.20D 01     0.00D 00
122     0 60D 02     0.50D 01     0.20D 01     0.00D 00
123     0 60D 02     0.10D 02     0.20D 01     0.00D 00
124     0 60D 02     0.15D 02     0.20D 01     0.00D 00
125     0.60D 02     0.20D 02     0.20D 01     0.00D 00
126     0 60D 02     0.25D 02     0.20D 01     0.00D 00
127     0 00D 00     0.00D 00     0.40D 01     0.00D 00
128     0 00D 00     0.50D 01     0.40D 01     0.00D 00
129     0.00D 00     0.10D 02     0.40D 01     0.00D 00
130     0.00D 00     0.15D 02     0.40D 01     0.00D 00
131     0.00D 00     0.20D 02     0.40D 01     0.00D 00
132     0 00D 00     0.25D 02     0.40D 01     0 00D 00
133     0 10D 02     0.00D 00     0.40D 01     0.00D 00
134     0 10D 02     0.50D 01     0.40D 01     0.00D 00
135     0 10D 02     0.10D 02     0.40D 01     0.00D 00
136     0. 10D 02    0.15D 02     0 40D 01     0 00D 00
137     0 10D 02     0.20D 02     0.40D 01     0 00D 00
138     0 10D 02     0.25D 02     0 40D 01     0 00D 00
139     0 20D 02     0 00D 00     0 40D 01     0.00D 00
140     0.20D 02     0 50D 01     0.40D 01     0 00D 00
141     0.20D 02     0.10D 02     0.40D 01     0 00D 00
142     0.20D 02     0.15D 02     0 40D 01     0.00D 00
143     0 20D 02     0.20D 02     0 40D 01     0.00D 00
144     0 20D 02     0.25D 02     0.40D 01     0.00D 00
145     0 30D 02     0.00D 00     0.40D 01     0.00D 00
146     0 30D 02     0.50D 01     0 40D 01     0.00D 00
147     0 30D 02     0.10D 02     0.40D 01     0.00D 00
148     0 30D 02     0.15D 02     0 40D 01     0.00D 00
149     0 30D 02     0 20D 02     0 40D 01     0.00D 00
150     0 30D 02     0.25D 02     0 40D 01     0 00D 00
151     0 40D 02     0 00D 00     0 40D 01     0.00D 00
152     0 40D 02     0.50D 01     0 40D 01     0.00D 00
153     0 40D 02     0.10D 02     0 40D 01     0 00D 00
154     0 40D 02     0 15D 02     0 40D 01     0 00D 00
155     0 40D 02     0 20D 02     0 40D 01     0 00D 00
156     0 40D 02     0 25D 02     0 40D 01     0 00D 00
157     0 50D 02     0.00D 00     0 40D 01     0.00D 00
158     0 50D 02     0.50D 01     0 40D 01     0 00D 00
159     0.50D 02     0.10D 02     0 40D 01     0 00D 00
160     0 50D 02     0.15D 02     0 40D 01     0.00D 00
161     0 50D 02     0.20D 02     0 40D 01     0 00D 00
162     0 50D 02     0.25D 02     0.40D 01     0 00D 00
163     0 60D 02     0 00D 00     0 40D 01     0.00D 00
164     0 60D 02     0 50D 01     0 40D 01     0.00D 00
165     0 60D 02     0 10D 02     0.40D 01     0 00D 00
166     0 60D 02     0.15D 02     0.40D 01     0 00D 00
167     0 60D 02     0.20D 02     0.40D 01     0.00D 00


168     0 60D 02     0 25D 02     0 40D 01     0 00D 00
```

NODE-ELEMENT RELATIONSHIP

. ELEMS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	2	8	7	43	44	50	49
2	2	3	9	18	44	45	51	50
3	3	4	10	19	45	46	52	51
4	4	5	11	20	46	47	53	52
5	5	6	12	21	47	48	54	53
6	7	8	14	13	49	50	56	55
7	8	9	15	14	50	51	57	56
8	9	10	16	15	51	52	58	57
9	10	11	17	16	52	53	59	58
10	11	12	18	17	53	54	60	59
11	13	14	20	19	55	56	62	61
12	14	15	21	20	56	57	63	62
13	15	16	22	21	57	58	64	63
14	16	17	23	22	58	59	65	64
15	17	18	24	23	59	60	66	65
16	19	20	26	25	61	62	68	67
17	20	21	27	26	62	63	69	68
18	21	22	28	27	63	64	70	69
19	22	23	29	28	64	65	71	70
20	23	24	30	29	65	66	72	71
21	25	26	32	31	67	68	74	73
22	26	27	33	32	68	69	75	74
23	27	28	34	33	69	70	76	75
24	28	29	35	34	70	71	77	76
25	29	30	36	35	71	72	78	77
26	31	32	38	37	73	74	80	79
27	32	33	39	38	74	75	81	80
28	33	34	40	39	75	76	82	81
29	34	35	41	40	76	77	83	82
30	35	36	42	41	77	78	84	83
31	43	44	50	49	85	86	92	91
32	44	45	51	50	86	87	93	92
33	45	46	52	51	87	88	94	93
34	46	47	53	52	88	89	95	94
35	47	48	54	53	89	90	96	95
36	49	50	56	55	91	92	98	97
37	50	51	57	56	92	93	99	98
38	51	52	58	57	93	94	100	99
39	52	53	59	58	94	95	101	100
40	53	54	60	59	95	96	102	101
41	55	56	62	61	97	98	104	103
42	56	57	63	62	98	99	105	104
43	57	58	64	63	99	100	106	105
44	58	59	65	64	100	101	107	106
45	59	60	66	65	101	102	108	107
46	61	62	68	67	103	104	110	109

47	62	63	69	68	104	105	111	110
48	63	64	70	69	105	106	112	111
49	64	65	71	70	106	107	113	112
50	65	66	72	71	107	108	114	113
51	67	68	74	73	109	110	116	115
52	68	69	75	74	110	111	117	116
53	69	70	76	75	111	112	118	117
54	70	71	77	76	112	113	119	118
55	71	72	78	77	113	114	120	119
56	73	74	80	79	115	116	122	121
57	74	75	81	80	116	117	123	122
58	75	76	82	81	117	118	124	123
59	76	77	83	82	118	119	125	124
60	77	78	84	83	119	120	126	125
61	85	86	92	91	127	128	134	133
62	86	87	93	92	128	129	135	134
63	87	88	94	93	129	130	136	135
64	88	89	95	94	130	131	137	136
65	89	90	96	95	131	132	138	137
66	91	92	98	97	133	134	140	139
67	92	93	99	98	134	135	141	140
68	93	94	100	99	135	136	142	141
69	94	95	101	100	136	137	143	142
70	95	96	102	101	137	138	144	143
71	97	98	104	103	139	140	146	145
72	98	99	105	104	140	141	147	146
73	99	100	106	105	141	142	148	147
74	100	101	107	106	142	143	149	148
75	101	102	108	107	143	144	150	149
76	103	104	110	109	145	146	152	151
77	104	105	111	110	146	147	153	152
78	105	106	112	111	147	148	154	153
79	106	107	113	112	148	149	155	154
80	107	108	114	113	149	150	156	155
81	109	110	116	115	151	152	158	157
82	110	111	117	116	152	153	159	158
83	111	112	118	117	153	154	160	159
84	112	113	119	118	154	155	161	160
85	113	114	120	119	155	156	162	161
86	115	116	122	121	157	158	164	163
87	116	117	123	122	158	159	165	164
88	117	118	124	123	159	160	166	165
89	118	119	125	124	160	161	167	166
90	119	120	126	125	161	162	168	167

```
                                        FIXED BOUNDARY CONDITIONS

  NODE         ID          NODE         ID          NODE         ID          NODE         ID          NODE         ID


     1          0             2          0             3          0             4          0             5          0
     6          0             7          0            12          0            13          0            18          0
    19          0            24          0            25          0            30          0            31          0
    36          0            37          0            38          0            39          0            40          0
    41          0            42          0            43          0            44          0            45          0
    46          0            47          0            48          0            49          0            54          0
    55          0            60          0            61          0            66          0            67          0
    72          0            73          0            78          0            79          0            80          0
    81          0            82          0            83          0            84          0            85          0
    86          0            87          0            88          0            89          0            90          0
    91          0            96          0            97          0           102          0           103          0
   108          0           109          0           114          0           115          0           120          0
   121          0           122          0           123          0           124          0           125          0
   125          0           127          0           128          0           129          0           130          0
   131          0           132          0           133          0           138          0           139          0
   144          0           145          0           150          0           151          0           156          0
   157          0           162          0           163          0           164          0           165          0
   166          0           167          0           168          0

                                MAXIMUM BANDWIDTH =  53 ON ROW NO  23
```

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                      OUTPUT FOR THREE-DIMENSIONAL
                      ----------------------------
               GROUNDWATER DISP BY FINITE ELEMENTS METHOD
               ------------------------------------------

                 INITIAL CONC DISTRIBUTION AT TIME =   0.000  HOURS

NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS

    1   0.0000 00       2   0.0000 00       3   0.0000 00       4   0.0000 00       5   0.0000 00
    6   0.0000 00       7   0.0000 00       8   0.0000 00       9   0.0000 00      10   0.0000 00
   11   0.0000 00      12   0.0000 00      13   0.0000 00      14   0.0000 00      15   0.0000 00
   16   0.0000 00      17   0.0000 00      18   0.0000 00      19   0.0000 00      20   0.0000 00
   21   0.0000 00      22   0.0000 00      23   0.0000 00      24   0.0000 00      25   0.0000 00
   26   0.0000 00      27   0.0000 00      28   0.0000 00      29   0.0000 00      30   0.0000 00
   31   0.0000 00      32   0.0000 00      33   0.0000 00      34   0.0000 00      35   0.0000 00
   36   0.0000 00      37   0.0000 00      38   0.0000 00      39   0.0000 00      40   0.0000 00
   41   0.0000 00      42   0.0000 00      43   0.0000 00      44   0.0000 00      45   0.0000 00
   46   0.0000 00      47   0.0000 00      48   0.0000 00      49   0.0000 00      50   0.0000 00
   51   0.0000 00      52   0.0000 00      53   0.0000 00      54   0.0000 00      55   0.0000 00
   56   0.0000 00      57   0.0000 00      58   0.0000 00      59   0.0000 00      60   0.0000 00
   61   0.0000 00      62   0.0000 00      63   0.0000 00      64   0.0000 00      65   0.0000 00
   66   0.0000 00      67   0.0000 00      68   0.0000 00      69   0.0000 00      70   0.0000 00
   71   0.0000 00      72   0.0000 00      73   0.0000 00      74   0.0000 00      75   0.0000 00
   76   0.0000 00      77   0.0000 00      78   0.0000 00      79   0.0000 00      80   0.0000 00
   81   0.0000 00      82   0.0000 00      83   0.0000 00      84   0.0000 00      85   0.0000 00
   86   0.0000 00      87   0.0000 00      88   0.0000 00      89   0.0000 00      90   0.0000 00
   91   0.0000 00      92   0.0000 00      93   0.0000 00      94   0.0000 00      95   0.0000 00
   96   0.0000 00      97   0.0000 00      98   0.0000 00      99   0.0000 00     100   0.0000 00
  101   0.0000 00     102   0.0000 00     103   0.0000 00     104   0.0000 00     105   0.0000 00
  106   0.0000 00     107   0.0000 00     108   0.0000 00     109   0.0000 00     110   0.0000 00
  111   0.0000 00     112   0.0000 00     113   0.0000 00     114   0.0000 00     115   0.0000 00
  116   0.0000 00     117   0.0000 00     118   0.0000 00     119   0.0000 00     120   0.0000 00
  121   0.0000 00     122   0.0000 00     123   0.0000 00     124   0.0000 00     125   0.0000 00
  126   0.0000 00     127   0.0000 00     128   0.0000 00     129   0.0000 00     130   0.0000 00
  131   0.0000 00     132   0.0000 00     133   0.0000 00     134   0.0000 00     135   0.0000 00
  136   0.0000 00     137   0.0000 00     138   0.0000 00     139   0.0000 00     140   0.0000 00
  141   0.0000 00     142   0.0000 00     143   0.0000 00     144   0.0000 00     145   0.0000 00
  146   0.0000 00     147   0.0000 00     148   0.0000 00     149   0.0000 00     150   0.0000 00
  151   0.0000 00     152   0.0000 00     153   0.0000 00     154   0.0000 00     155   0.0000 00
  156   0.0000 00     157   0.0000 00     158   0.0000 00     159   0.0000 00     160   0.0000 00
  161   0.0000 00     162   0.0000 00     163   0.0000 00     164   0.0000 00     165   0.0000 00
  166   0.0000 00     167   0.0000 00     168   0.0000 00
```

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                                   CONCENTRATION DISTRIBUTION AT TIME • 480 000 HOURS

NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

    1    0 579D 00        2    0 776D 03        3    0.121D 06        4    0 775D 03        5    0 863D 00
    6    0.256D 00        7    0 168D 00        8    0.319D 03        9    0.342D 03       10    0.318D 03
   11    0 252D 00       12    0.696D-01       13    0.417D-02       14    0.150D 02       15    0 297D 03
   16    0 150D 02       17    0 628D-02       18    0.137D-02       19    0.184D-04       20    0.853D-01
   21    0 310D 01       22    0 953D-01       23    0.285D-04       24    0.356D-05       25    0.167D-07
   26    0 790D-04       27    0.212D-02       28    0.780D-04       29    0.253D-07       30    0.171D-08
   31    0 240D-11       32    0.948D-08       33    0.226D-06       34    0.948D-08       35    0.322D-11
   36    0 143D-12       37    0.509D-16       38    0.162D-12       39    0 366D-11       40    0.162D-12
   41    0 568D-16       42    0.175D-17       43    0.615D 00       44    0.712D 03       45    0.173D 06
   46    0.712D 03       47    0 822D 00       48    0.355D 00       49    0.170D 00       50    0.288D 03
   51    0 429D 05       52    0.288D 03       53    0.236D 00       54    0 866D-01       55    0 383D-02
   56    0 137D 02       57    0.790D 03       58    0.137D 02       59    0 573D-02       60    0.133D-02
   61    0 167D-04       62    0.830D-01       63    0.284D 01       64    0.830D-01       65    0 259D-04
   66    0 318D-05       67    0.152D-07       68    0.718D-04       69    0.194D-02       70    0.718D-04
   71    0 231D-07       72    0.154D-08       73    0.219D-11       74    0.853D-08       75    0.207D-06
   76    0 853D-08       77    0.294D-11       78    0.128D-12       79    0.466D-16       80    0 148D-12
   81    0.333D-11       82    0.148D-12       83    0.391D-16       84    0.157D-17       85    0.321D 00
   86    0.521D 03       87    0.714D 05       88    0.521D 03       89    0.474D 00       90    0.139D 00
   91    0 946D-01       92    0.209D 03       93    0.206D 05       94    0.209D 03       95    0.141D 00
   96    0.379D-01       97    0.256D-02       98    0.990D 00       99    0 518D 03      100    0.990D 00
  101    0 384D-02      102    0 789D-03      103    0.123D-04      104    0 638D-01      105    0.207D 01
  106    0 618D-01      107    0.192D-04      108    0.226D-05      109    0.113D-07      110    0.534D-04
  111    0 143D-02      112    0 534D-04      113    0.114D-07      114    0.112D-08      115    0.167D-11
  116    0 644D-08      117    0.156D-06      118    0.644D-08      119    0.221D-11      120    0.955D-13
  121    0 351D-16      122    0 111D-12      123    0.249D-11      124    0.111D-12      125    0.389D-16
  126    0.118D-17      127    0 347D-01      128    0.136D 03      129    0 734D 04      130    0.136D 03
  131    0 600D-01      132    0 116D-01      133    0.130D-01      134    0.554D 02      135    0.269D 04
  136    0 554D 02      137    0.189D-01      138    0.400D-02      139    0.553D-03      140    0.275D 01
  141    0 105D 03      142    0.275D 01      143    0.835D-03      144    0.129D-03      145    0.351D-05
  146    0 178D-01      147    0.540D 00      148    0 178D-01      149    0.648D-05      150    0 505D-06
  151    0 351D-08      152    0.158D-04      153    0.409D-03      154    0.158D-04      155    0.519D-08
  156    0 297D-09      157    0.527D-12      158    0.185D-08      159    0.463D-07      160    0 195D-08
  161    0 678D-12      162    0.273D-13      163    0.111D-16      164    0.341D-13      165    0.763D-12
  166    0 341D-13      167    0.120D-16      168    0.343D-18
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                              CONCENTRATION DISTRIBUTION AT TIME = 240.000 HOURS

NODES      CONCS     NODES      CONCS     NODES      CONCS     NODES      CONCS     NODES       CONC$

    1   0 126D 01        2   0.116D 04        3   0.273D 06        4   0.116D 04        5   0.177D 01
    6   0 613D 00        7   0.266D-01        8   0.125D 03        9   0.600D 04       10   0.125D 03
   11   0 385D-01       12   0.752D-02       13   0.412D-04       14   0.194D-01       15   0.476D 01
   16   0 194D 00       17   0 643D-04       18   0.369D-06       19   0.212D-08       20   0 650D-05
   21   0.141D-03       22   0 650D-05       23   0.237D-08       24   0.678D-10       25   0.226D-14
   26   0.504D-11       27   0.103D-09       28   0.504D-11       29   0.170D-14       30   0.179D-16
   31   0 478D-22       32   0.846D-19       33   0.169D-17       34   0.847D-19       35   0.266D-22
   36   0.678D-25       37   0.207D-31       38   0.325D-28       39   0.636D-27       40   0.325D-27
   41   0.873D-30       42   0.233D-36       43   0.145D 01       44   0 105D 04       45   0.512D 06
   46   0 105D 04       47   0.170D 01       48   0.107D 01       49   0.240D-01       50   0.111D 03
   51   0 469D 04       52   0.111D 03       53   0.347D-01       54   0.670D-02       55   0 373D-04
   56   0 174D 00       57   0 441D 01       58   0.174D 00       59   0.586D-04       60   0.331D-05
   61   0 194D-08       62   0 587D-05       63   0.131D-03       64   0.587D-06       65   0.259D-08
   66   0 613D-10       67   0.207D-14       68   0.441D-11       69   0.945D-10       70   0.441D-11
   71   0.154D-14       72   0.163D-16       73   0.436D-22       74   0.775D-19       75   0.156D-17
   76   0.775D-19       77   0.242D-22       78   0.524D-25       79   0.188D-31       80   0.297D-28
   81   0 580D-27       82   0.297D-28       83   0.893D-32       84   0.209D-35       85   0.683D 00
   86   0.780D 03       87   0.157D 06       88   0.780D 03       89   0.950D 00       90   0.322D 00
   91   0 170D-01       92   0.834D 02       93   0.378D 04       94   0.834D 02       95   0.249D-01
   96   0 464D-02       97   0.280D-04       98   0.131D 00       99   0.335D 01      100   0.131D 00
  101   0 431D-04      102   0.240D-05      103   0.148D-08      104   0.452D-06      105   0.100D-03
  106   0 452D-05      107   0.161D-08      108   0.463D-10      109   0.156D-14      110   0.346D-11
  111   0 715D-10      112   0.346D-11      113   0.116D-14      114   0.121D-16      115   0.333D-22
  116   0 590D-19      117   0.118D-17      118   0.590D-19      119   0.185D-22      120   0.391D-25
  121   0.140D-31      122   0.226D-28      123   0.439D-27      124   0.226D-28      125   0.674D-32
  126   0 157D-35      127   0 551D-01      128   0.203D 03      129   0.119D 05      130   0.203D 03
  131   0 803D-01      132   0.191D-01      133   0.435D-02      134   0.232D 02      135   0.818D 03
  136   0 232D 02      137   0.666D-02      138   0.910D-03      139   0.877D-05      140   0.392D-01
  141   0.980D 00      142   0.392D-01      143   0.132D-04      144   0.674D-06      145   0.470D-09
  146   0 139D-05      147   0.308D-04      148   0.139D-06      149   0.498D-09      150   0.134D-17
  151   0 499D-15      152   0.109D-11      153   0.224D-10      154   0.109D-11      155   0.365D-15
  156   0.350D-17      157   0.107D-22      158   0.189D-19      159   0.376D-18      160   0.189D-19
  161   0 588D-23      162   0.114D-25      163   0.460D-32      164   0.722D-29      165   0.141D-27
  166   0 722D-29      167   0.216D-32      168   0.457D-36
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                        OUTPUT FOR THREE-DIMENSIONAL
                        ----------------------------
                  GROUNDWATER DISP BY FINITE ELEMENTS METHOD
                  ------------------------------------------

                    INITIAL CONC DISTRIBUTION AT TIME =   0.000 HOURS
NODES    CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS

   1   0.0000D 00      2   0.0000D 00      3   0.0000D 00      4   0.0000D 00      5   0.0000D 00
   6   0.0000D 00      7   0.0000D 00      8   0.0000D 00      9   0.0000D 00     10   0.0000D 00
  11   0.0000D 00     12   0.0000D 00     13   0.0000D 00     14   0.0000D 00     15   0.0000D 00
  16   0.0000D 00     17   0.0000D 00     18   0.0000D 00     19   0.0000D 00     20   0.0000D 00
  21   0.0000D 00     22   0.0000D 00     23   0.0000D 00     24   0.0000D 00     25   0.0000D 00
  26   0.0000D 00     27   0.0000D 00     28   0.0000D 00     29   0.0000D 00     30   0.0000D 00
  31   0.0000D 00     32   0.0000D 00     33   0.0000D 00     34   0.0000D 00     35   0.0000D 00
  36   0.0000D 00     37   0.0000D 00     38   0.0000D 00     39   0.0000D 00     40   0.0000D 00
  41   0.0000D 00     42   0.0000D 00     43   0.0000D 00     44   0.0000D 00     45   0.0000D 00
  46   0.0000D 00     47   0.0000D 00     48   0.0000D 00     49   0.0000D 00     50   0.0000D 00
  51   0.0000D 00     52   0.0000D 00     53   0.0000D 00     54   0.0000D 00     55   0.0000D 00
  56   0.0000D 00     57   0.0000D 00     58   0.0000D 00     59   0.0000D 00     60   0.0000D 00
  61   0.0000D 00     62   0.0000D 00     63   0.0000D 00     64   0.0000D 00     65   0.0000D 00
  66   0.0000D 00     67   0.0000D 00     68   0.0000D 00     69   0.0000D 00     70   0.0000D 00
  71   0.0000D 00     72   0.0000D 00     73   0.0000D 00     74   0.0000D 00     75   0.0000D 00
  76   0.0000D 00     77   0.0000D 00     78   0.0000D 00     79   0.0000D 00     80   0.0000D 00
  81   0.0000D 00     82   0.0000D 00     83   0.0000D 00     84   0.0000D 00     85   0.0000D 00
  86   0.0000D 00     87   0.0000D 00     88   0.0000D 00     89   0.0000D 00     90   0.0000D 00
  91   0.0000D 00     92   0.0000D 00     93   0.0000D 00     94   0.0000D 00     95   0.0000D 00
  96   0.0000D 00     97   0.0000D 00     98   0.0000D 00     99   0.0000D 00    100   0.0000D 00
 101   0.0000D 00    102   0.0000D 00    103   0.0000D 00    104   0.0000D 00    105   0.0000D 00
 106   0.0000D 00    107   0.0000D 00    108   0.0000D 00    109   0.0000D 00    110   0.0000D 00
 111   0.0000D 00    112   0.0000D 00    113   0.0000D 00    114   0.0000D 00    115   0.0000D 00
 116   0.0000D 00    117   0.0000D 00    118   0.0000D 00    119   0.0000D 00    120   0.0000D 00
 121   0.0000D 00    122   0.0000D 00    123   0.0000D 00    124   0.0000D 00    125   0.0000D 00
 126   0.0000D 00    127   0.0000D 00    128   0.0000D 00    129   0.0000D 00    130   0.0000D 00
 131   0.0000D 00    132   0.0000D 00    133   0.0000D 00    134   0.0000D 00    135   0.0000D 00
 136   0.0000D 00    137   0.0000D 00    138   0.0000D 00    139   0.0000D 00    140   0.0000D 00
 141   0.0000D 00    142   0.0000D 00    143   0.0000D 00    144   0.0000D 00    145   0.0000D 00
 146   0.0000D 00    147   0.0000D 00    148   0.0000D 00    149   0.0000D 00    150   0.0000D 00
 151   0.0000D 00    152   0.0000D 00    153   0.0000D 00    154   0.0000D 00    155   0.0000D 00
 156   0.0000D 00    157   0.0000D 00    158   0.0000D 00    159   0.0000D 00    160   0.0000D 00
 161   0.0000D 00    162   0.0000D 00    163   0.0000D 00    164   0.0000D 00    165   0.0000D 00
 166   0.0000D 00    167   0.0000D 00    168   0.0000D 00
```

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                          CONCENTRATION DISTRIBUTION AT TIME = 240.000 HOURS
NODES       CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

   1    0 137D 01        2    0.112D 04        3    0.381D 06        4    0.112D 04        5    0 176D 01
   6    0 835D 00        7    0.258D-01        8    0.122D 03        9    0.483D 04       10    0 122D 03
  11    0 372D-01       12    0 725D-02       13    0.401D-04       14    0.188D 00       15    0 462D 01
  16    0.188D 00       17    0 624D-04       18    0.362D-05       19    0.205D-08       20    0 630D-05
  21    0 137D-03       22    0.630D-05       23    0.226D-08       24    0.658D-10       25    0.219D-14
  26    0 489D-11       27    0.100D-09       28    0 489D-11       29    0 164D-14       30    0 175D-16
  31    0 464D-22       32    0.822D-19       33    0.165D-17       34    0.822D-19       35    0.259D-22
  36    0 564D-25       37    0.200D-31       38    0.316D-28       39    0 617D-27       40    0.316D-28
  41    0 946D-32       42    0.226D-35       43    0.124D 01       44    0.103D 04       45    0 373D 06
  46    0.103D 04       47    0.158D 01       48    0.787D 00       49    0.233D-01       50    0.108D 03
  51    0 455D 04       52    0.108D 03       53    0.337D 00       54    0.649D-02       55    0 363D-04
  56    0.170D 00       57    0.430D 01       58    0.170D 00       59    0.571D-02       60    0.323D-05
  61    0 189D-08       62    0.573D-05       63    0.127D 03       64    0.573D-05       65    0.208D-04
  66    0.596D-10       67    0.202D-14       68    0 449D-11       69    0.922D-10       70    0 449D-11
  71    0.151D-07       72    0.159D-16       73    0 426D-22       74    0.756D-19       75    0 152D-17
  76    0 756D-19       77    0.237D-11       78    0.511D-25       79    0 185D-31       80    0 287D-28
  81    0.562D-27       82    0.287D-28       83    0.871D-32       84    0.203D-35       85    0 751D 00
  86    0.770D 03       87    0.217D 06       88    0.770D 03       89    0.980D 00       90    0 435D 00
  91    0 170D-01       92    0.825D 02       93    0.336D 04       94    0.825D 02       95    0.247D-01
  96    0 452D-02       97    0.278D-04       98    0.131D 00       99    0.333D 01      100    0.131D 00
 101    0 428D-04      102    0.238D-05      103    0.146D-08      104    0 446D-05      105    0 100D-03
 106    0 446D-05      107    0.160D-08      108    0.458D-10      109    0.150D-14      110    0 334D-11
 111    0 709D-10      112    0.334D-11      113    0.117D-14      114    0.120D-16      115    0 330D-22
 116    0 586D-18      117    0.118D-17      118    0.586D-18      119    0.183D-22      120    0.389D-25
 121    0 142D-31      122    0.223D-28      123    0 436D-27      124    0.223D-28      125    0 669D-32
 126    0 156D-35      127    0 697D-01      128    0.221D 03      129    0.151D 05      130    0 221D 03
 131    0 106D 00      132    0 250D-01      133    0.489D-02      134    0.251D 02      135    0 910D 03
 136    0 251D 02      137    0.727D-02      138    0 105D-02      139    0 930D-05      140    0 421D-01
 141    0 107D 01      142    0.421D-01      143    0.141D-04      144    0.731D-06      145    0.501D-09
 146    0.148D-05      147    0.330D-04      148    0.148D-05      149    0 533D-09      150    0 145D-10
 151    0 530D-15      152    0 116D-11      153    0.239D-10      154    0 116D-11      155    0 389D-15
 156    0 377D-17      157    0.114D-22      158    0.200D-19      159    0 400D-18      160    0 200D-18
 161    0 626D-23      162    0 123D-25      163    0.489D-32      164    0 768D-29      165    0 150D-27
 166    0 768D-29      167    0.230D-32      168    0.483D-36
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                                   CONCENTRATION DISTRIBUTION AT TIME = 480.000 HOURS
NUDES      CONCS      NUDES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

    1      0 608D 00      2      0 753D 03      3      0.144D 06      4      0 753D 03      5      0 858D 00
    6      0 308D 00      7      0.172D 00      8      0.309D 03      9      0.382D 05     10      0 309D 03
   11      0 250D 00     12      0.787D-01     13      0.411D-02     14      0.147D 02     15      0 808D 03
   16      0.147D 02     17      0.614D-02     18      0.136D-02     19      0.179D-04     20      0.823D-01
   21      0.302D 01     22      0.823D-01     23      0.277D-04     24      0.344D-05     25      0.163D-07
   26      0 766D-04     27      0.205D-02     28      0.766D-04     29      0.246D-07     30      0.165D-08
   31      0 234D-11     32      0.820D-08     33      0.220D-06     34      0.820D-08     35      0.312D-11
   36      0 138D-12     37      0 494D-16     38      0.157D-12     39      0.354D-11     40      0.157D-12
   41      0 551D-16     42      0.170D-17     43      0.594D 00     44      0.702D 03     45      0.138D 06
   46      0 702D 03     47      0.766D 00     48      0.284D 00     49      0.156D 00     50      0 282D 03
   51      0.362D 05     52      0 282D 03     53      0.223D 00     54      0.716D-01     55      0 367D-02
   56      0 133D 02     57      0.742D 03     58      0.133D 02     59      0.553D-02     60      0.123D-02
   61      0 163D-04     62      0.812D 01     63      0.277D 01     64      0.812D 01     65      0.252D-04
   66      0.309D-05     67      0.148D-07     68      0 703D-04     69      0.189D-02     70      0 703D-04
   71      0.225D-07     72      0.150D-08     73      0.214D-11     74      0.836D-08     75      0.203D-06
   76      0.836D-08     77      0.286D-11     78      0.125D-12     79      0.454D-16     80      0 143D-12
   81      0.325D-11     82      0.143D-12     83      0.604D-16     84      0.153D-17     85      0.342D 00
   86      0 517D 03     87      0.848D 05     88      0.517D 03     89      0.484D 00     90      0 166D 00
   91      0.890D-01     92      0.208D 03     93      0.231D 05     94      0.208D 03     95      0.143D 00
   96      0.431D-01     97      0.257D-02     98      0.890D 01     99      0 528D 03    100      0.990D 01
  101      0.383D-02    102      0.811D-03    103      0.123D-04    104      0.609D-01    105      0 207D 01
  106      0 609D-01    107      0.190D-04    108      0.225D-05    109      0.113D-07    110      0.515D-04
  111      0 142D-02    112      0 515D-04    113      0 170D-07    114      0.111D-08    115      0 165D-11
  116      0.634D-08    117      0.154D-06    118      0 634D-08    119      0.219D-11    120      0 947D-13
  121      0.348D-16    122      0 109D-12    123      0 248D-11    124      0.108D-12    125      0.386D-16
  126      0 117D-17    127      0 424D-01    128      0.148D 03    129      0.910D 04    130      0.149D 03
  131      0 632D-01    132      0 140D-01    133      0.154D-01    134      0.605D 02    135      0.324D 04
  136      0 605D 02    137      0.228D-01    138      0 497D-02    139      0.620D-03    140      0 299D 01
  141      0.118D 03    142      0 299D 01    143      0.830D-03    144      0.151D-03    145      0.380D-05
  146      0.192D-01    147      0.594D 00    148      0 192D-01    149      0 592D-05    150      0 568D-06
  151      0 375D-08    152      0 168D-04    153      0 442D-03    154      0.168D-04    155      0 556D-08
  156      0 325D-09    157      0 560D-12    158      0.209D-08    159      0 497D-03    160      0 209D-08
  161      0 725D-12    162      0.294D-13    163      0.119D-16    164      0.365D-13    165      0 814D-12
  166      0 365D-13    167      0.128D-16    168      0.368D-18
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                          CONCENTRATION DISTRIBUTION AT TIME = 720.000 HOURS

NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS      NODES    CONCS

    1    0.462D 00      2    0.606D 03      3    0.108D 06      4    0 606D 03      5    0.654D 00
    6    0.230D 00      7    0.242D 00      8    0.367D 03      9    0.552D 05     10    0 367D 03
   11    0.344D 00     12    0.116D 00     13    0.252D-01     14    0 539D 02     15    0 551D 04
   16    0.539D 02     17    0.367D-01     18    0.110D-03     19    0 610D-03     20    0 206D 01
   21    0.126D 03     22    0.206D 01     23    0 903D-03     24    0 214D-03     25    0 441D-05
   26    0 196D-01     27    0.822D 00     28    0.196D-01     29    0 671D-05     30    0 111D-05
   31    0.100D-07     32    0.496D-04     33    0.162D-02     34    0 496D-04     35    0 154D-07
   36    0.166D-08     37    0.708D-11     38    0.335D-07     39    0.942D-06     40    0 335D-07
   41    0.106D-10     42    0.766D-12     43    0.417D 00     44    0.565D 03     45    0.105D 06
   46    0.565D 03     47    0.585D 00     48    0.212D 00     49    0 219D 00     50    0 333D 03
   51    0.526D 05     52    0.333D 03     53    0 307D 00     54    0 106D 00     55    0 224D-01
   56    0.490D 02     57    0.510D 04     58    0.490D 02     59    0.329D-01     60    0 980D-02
   61    0.550D-03     62    0.181D 01     63    0.116D 03     64    0 181D 01     65    0 817D-03
   66    0.192D-03     67    0.398D-05     68    0.178D-01     69    0.747D 00     70    0 178D-01
   71    0 603D-05     72    0.100D-05     73    0.907D-08     74    0 447D-04     75    0 147D-02
   76    0.447D-04     77    0.140D-07     78    0.150D-08     79    0 648D-11     80    0.304D-07
   81    0.854D-06     82    0.304D-07     83    0.977D-11     84    0 691D-12     85    0 262D 00
   86    0.418D 03     87    0.610D 05     88    0.416D 03     89    0.373D 00     90    0.126D 00
   91    0.137D 00     92    0.247D 03     93    0.329D 05     94    0.247D 03     95    0 197D 00
   96    0 630D-01     97    0.147D-01     98    0.363D 02     99    0 336D 04    100    0 363D 02
  101    0.215D-01    102    0.607D-02    103    0.383D-03    104    0.135D 01    105    0 797D 02
  106    0.135D 01    107    0.571D-03    108    0.128D-03    109    0 291D-05    110    0 129D-01
  111    0.539D 00    112    0.129D-01    113    0 442D-05    114    0 691D-06    115    0 689D-08
  116    0.337D-04    117    0.109D-02    118    0.337D-04    119    0.106D-07    120    0 108D-08
  121    0.493D-11    122    0.232D-07    123    0.639D-06    124    0 230D-07    125    0 742D-11
  126    0 513D-12    127    0.336D-01    128    0.121D 03    129    0.722D 04    130    0 121D 03
  131    0.800D-01    132    0.115D-01    133    0.191D-01    134    0.716D 02    135    0 406D 04
  136    0 716D 02    137    0.284D-01    138    0.635D-02    139    0.256D-02    140    0 107D 02
  141    0.527D 03    142    0.107D 02    143    0.381D-02    144    0 773D-03    145    0 878D-04
  146    0 408D 00    147    0.167D 02    148    0.408D 00    149    0.132D-03    150    0 219D-04
  151    0 816D-06    152    0.406D-02    153    0.139D 00    154    0 406D-02    155    0.126D-05
  156    0.151D-06    157    0 217D-08    158    0.107D-04    159    0 317D-03    160    0 107D-04
  161    0.334D-08    162    0.281D-09    163    0.164D-11    164    0.742D-08    165    0 197D-06
  166    0.742D-08    167    0.242D-11    168    0.147D-12
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                                   CONCENTRATION DISTRIBUTION AT TIME = 960.000 HOURS
NODES       CONCS     . NODES      CONCS      NODES      CONCS     NODES      CONCS    NODES      CONCS

   1       0 389D 00       2     0.523D 03       3     0.910D 05      4     0.523D 03      5     0.553D 00
   6       0 193D 00       7     0.262D 00       8     0.381D 03      9     0 600D 05     10     0.381D 03
  11       0 371D 00      12     0.127D 00      13     0.550D-01     14     0.970D 02     15     0.124D 05
  16       0 970D 02      17     0.793D-01      18     0.253D-01     19     0.378D-02     20     0.904D 01
  21       0.837D 03      22     0.904D 01      23     0 550D-02     24     0.168D-02     25     0 932D-04
  26       0 294D 00      27     0.197D 02      28     0.294D 00     29     0.138D-03     30     0.333D-04
  31       0 867D-06      32     0.352D-02      33     0.172D 00     34     0.352D-02     35     0.130D-05
  36       0 248D-06      37     0.328D-11      38     0.391D-04     39     0.584D-03     40     0.391D-04
  41       0 501D-08      42     0.704D-08      43     0.352D 00     44     0 491D 03     45     0 874D 05
  46       0 491D 03      47     0 495D 00      48     0.178D 00     49     0.236D 00     50     0.348D 03
  51       0.574D 05      52     0.348D 03      53     0.332D 00     54     0.717D 00     55     0 492D-01
  56       0 883D 02      57     0.116D 05      58     0.883D 02     59     0.705D-01     60     0.232D-01
  61       0 337D-02      62     0.795D 01      63     0.771D 03     64     0 795D-01     65     0 490D-02
  66       0 141D-02      67     0.837D-04      68     0.268D 00     69     0.180D 02     70     0.268D 00
  71       0 123D-03      72     0.300D-04      73     0.778D-08     74     0.318D-02     75     0 155D 00
  76       0 318D-02      77     0 117D-05      78     0.223D-06     79     0.299D-08     80     0 140D-04
  81       0 529D-03      82     0.140D-04      83     0.453D-08     84     0.630D-09     85     0 222D 00
  86       0.362D 03      87     0.845D 05      88     0.362D 03     89     0.314D 00     90     0.106D 00
  91       0 148D 00      92     0.258D 03      93     0.359D 05     94     0.258D 03     95     0 211D 00
  96       0 702D-01      97     0.316D-01      98     0.651D 02     99     0.743D 04    100     0.651D 02
 101       0.454D-01     102     0.142D-01     103     0.226D-02    104     0.589D 01    105     0.504D 03
 106       0 589D 01     107     0.328D-02     108     0.902D-03    109     0.578D-04    110     0 193D 00
 111       0 122D 02     112     0.193D 00     113     0.859D-04    114     0.198D-04    115     0.566D-06
 116       0 238D-02     117     0.111D 00     118     0.238D-02    119     0.852D-06    120     0 153D-06
 121       0 222D-08     122     0 105D-04     123     0.387D-03    124     0.105D-04    125     0.337D-08
 126       0 447D-09     127     0.291D-01     128     0 105D 03    129     0.617D 04    130     0 105D 03
 131       0 431D-01     132     0.101D-01     133     0.205D-01    134     0.746D 02    135     0 425D 04
 136       0 746D 02     137     0.300D-01     138     0.691D-02    139     0.488D-02    140     0 190D 02
 141       0 101D 04     142     0 190D 02     143     0.728D-02    144     0.158D-02    145     0 411D-03
 146       0 175D 01     147     0 826D 02     148     0.175D 01    149     0 612D-03    150     0 119D-03
 151       0 129D-04     152     0 591D-01     153     0 244D 01    154     0 591D-01    155     0 193D-04
 156       0 323D-05     157     0 148D-06     158     0 730D-03    159     0 264D-01    160     0 730D-03
 161       0 226D-06     162     0 302D-07     163     0 655D-09    164     0.327D-05    165     0 105D-03
 166       0 327D-05     167     0.101D-08     168     0.104D-09
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                                   CONCENTRATION DISTRIBUTION AT TIME =1200.000 HOURS
NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

    1      0 331D 00      2      0 484D 03      3      0.687D 05      4      0.484D 03      5      0.495D 00
    6      0 144D 00      7      0.255D 00      8      0.392D 03      9      0.524D 05     10      0.392D 03
   11      0.379D 00     12      0.110D 00     13      0.798D-01     14      0.138D 03     15      0.165D 05
   16      0 138D 03     17      0.120D 00     18      0.340D-01     19      0.130D-01     20      0.217D 02
   21      0 216D 04     22      0.217D 02     23      0.153D-01     24      0.416D-02     25      0 579D-03
   26      0.147D 01     27      0.122D 03     28      0.147D 01     29      0 869D-03     30      0.219D-03
   31      0 141D-04     32      0.447D-01     33      0.298D 01     34      0.447D-01     35      0.211D-04
   36      0 483D-05     37      0.158D-06     38      0.608D-03     39      0.318D-01     40      0 608D-03
   41      0 238D-06     42      0 467D-07     43      0.348D 00     44      0 435D 03     45      0.763D 05
   46      0 435D 03     47      0.433D 00     48      0.195D 00     49      0.266D 00     50      0.344D 03
   51      0.574D 05     52      0.344D 03     53      0.331D 00     54      0.146D 00     55      0.816D-01
   56      0 120D 03     57      0.174D 05     58      0.120D 03     59      0.104D 00     60      0.433D-01
   61      0 105D-01     62      0.184D 02     63      0.222D 04     64      0.184D 02     65      0.134D 01
   66      0 511D-02     67      0.570D-03     68      0 130D 01     69      0.120D 03     70      0.130D 01
   71      0 757D-03     72      0.251D-03     73      0.134D-04     74      0.335D-01     75      0.274D 01
   76      0 335D-01     77      0 185D-04     78      0.517D-05     79      0.146D-06     80      0.498D-03
   81      0.285D-01     82      0 499D-03     83      0.187D-06     84      0.467D-07     85      0.185D 00
   86      0 323D 03     87      0.476D 05     88      0.323D 03     89      0.276D 00     90      0.784D-01
   91      0 142D 00     92      0.250D 03     93      0.360D 05     94      0.250D 03     95      0.211D 00
   96      0 589D-01     97      0 445D-01     98      0.890D 02     99      0 111D 05    100      0.890D 02
  101      0 666D-01    102      0.182D-01    103      0.588D-02    104      0 137D 02    105      0.140D 04
  106      0 137D 02    107      0 889D-02    108      0 231D-02    109      0.339D-03    110      0.940D 00
  111      0 779D 02    112      0.940D 00    113      0.511D-03    114      0.123D-03    115      0.860D-05
  116      0 293D-01    117      0.187D 01    118      0.293D-01    119      0.149D-04    120      0.279D-05
  121      0 100D-06    122      0.399D-03    123      0.200D-01    124      0 399D-03    125      0.149D-06
  126      0 279D-07    127      0 211D-01    128      0.930D 02    129      0.545D 04    130      0.930D 02
  131      0 386D-01    132      0 686D-02    133      0.166D-01    134      0.740D 02    135      0 423D 04
  136      0 740D 02    137      0.300D-01    138      0 556D-02    139      0.565D-02    140      0.259D 02
  141      0 142D 04    142      0 259D 02    143      0.101D-02    144      0.176D-02    145      0.850D-03
  146      0 403D 01    147      0.205D 03    148      0.403D 01    149      0.149D-02    150      0 251D-03
  151      0 567D-04    152      0 282D 00    153      0 131D 02    154      0.282D 00    155      0.980D-04
  156      0 152D-04    157      0 169D-05    158      0 885D-02    159      0 367D 00    160      0 885D-02
  161      0 288D-05    162      0 402D-06    163      0 226D-07    164      0.122D-03    165      0.456D-02
  166      0 122D-03    167      0 344D-07    168      0 482D-08
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APPENDIX F

INPUT/OUTPUT OF FIELD APPLICATION PROBLEM

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                  INPUT DATA FOR THREE-DIMENSIONAL
                  --------------------------------
              GROUNDWATER DISP BY FINITE ELEMENT METHOD
              -----------------------------------------


TOTAL NO  OF ELEMENTS              = 154
TOTAL NO  OF NODES                 = 360
MAXIMUM NO  OF NODES PER ELEMENT   =   8
TOTAL NO. OF MATERIALS             =   1
NUMBER OF PUMPING WELLS            =   0
NUMBER OF CONCS TO BE ESTIMATED    = 360



NUMBER OF PUMPING PERIODS          =   0
TOTAL SIMULATION PERIODS           =  16
FACTOR MULTIPLYING COMPUTED CONCS  =   1 00000



STEP SIZE                          =  24 00000
STATE OF PROBLEM                   =   1
NO  OF SPECIFIED CONDITIONS        = 100
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                    COORDINATES AND INITIAL CONCS OF NODES (L)

NODES        X(I)          Y(I)          Z(I)          CINT(I)

   1       0.00D 00      0.00D 00      0.10D 02      0.00D 00
   2       0.00D 00      0.11D 04      0.10D 02      0.00D 00
   3       0.00D 00      0.15D 04      0.10D 02      0.00D 00
   4       0.00D 00      0.18D 04      0.10D 02      0.00D 00
   5       0.00D 00      0.20D 04      0.10D 02      0.00D 00
   6       0.00D 00      0.21D 04      0.10D 02      0.00D 00
   7       0.00D 00      0.24D 04      0.10D 02      0.50D 02
   8       0.00D 00      0.25D 04      0.10D 02      0.10D 03
   9       0.00D 00      0.27D 04      0.10D 02      0.15D 03
  10       0.00D 00      0.30D 04      0.10D 02      0.15D 03
  11       0.00D 00      0.32D 04      0.10D 02      0.10D 03
  12       0.00D 00      0.35D 04      0.10D 02      0.50D 02
  13       0.00D 00      0.37D 04      0.10D 02      0.00D 00
  14       0.00D 00      0.45D 04      0.10D 02      0.00D 00
  15       0.00D 00      0.57D 04      0.10D 02      0.00D 00
  16       0.12D 04      0.00D 00      0.10D 02      0.00D 00
  17       0.12D 04      0.11D 04      0.10D 02      0.00D 00
  18       0.12D 04      0.15D 04      0.10D 02      0.00D 00
  19       0.12D 04      0.18D 04      0.10D 02      0.00D 00
  20       0.12D 04      0.20D 04      0.10D 02      0.88D 02
  21       0.12D 04      0.21D 04      0.10D 02      0.15D 03
  22       0.12D 04      0.24D 04      0.10D 02      0.18D 03
  23       0.12D 04      0.25D 04      0.10D 02      0.14D 03
  24       0.12D 04      0.27D 04      0.10D 02      0.10D 03
  25       0.12D 04      0.30D 04      0.10D 02      0.50D 02
  26       0.12D 04      0.32D 04      0.10D 02      0.00D 00
  27       0.12D 04      0.35D 04      0.10D 02      0.00D 00
  28       0.12D 04      0.37D 04      0.10D 02      0.00D 00
  29       0.12D 04      0.45D 04      0.10D 02      0.00D 00
  30       0.12D 04      0.57D 04      0.10D 02      0.00D 00
  31       0.23D 04      0.00D 00      0.10D 02      0.00D 00
  32       0.23D 04      0.11D 04      0.10D 02      0.00D 00
  33       0.23D 04      0.15D 04      0.10D 02      0.00D 00
  34       0.23D 04      0.18D 04      0.10D 02      0.00D 00
  35       0.23D 04      0.20D 04      0.10D 02      0.10D 03
  36       0.23D 04      0.21D 04      0.10D 02      0.15D 03
  37       0.23D 04      0.24D 04      0.10D 02      0.18D 03
  38       0.23D 04      0.25D 04      0.10D 02      0.19D 03
  39       0.23D 04      0.27D 04      0.10D 02      0.18D 03
  40       0.23D 04      0.30D 04      0.10D 02      0.83D 02
  41       0.23D 04      0.32D 04      0.10D 02      0.92D 02
  42       0.23D 04      0.35D 04      0.10D 02      0.50D 02
  43       0.23D 04      0.37D 04      0.10D 02      0.00D 00
  44       0.23D 04      0.45D 04      0.10D 02      0.00D 00
  45       0.23D 04      0.57D 04      0.10D 02      0.00D 00
  46       0.35D 04      0.00D 00      0.10D 02      0.00D 00
  47       0.35D 04      0.11D 04      0.10D 02      0.00D 00

  48       0.35D 04      0.15D 04      0.10D 02      0.00D 00
  49       0.35D 04      0.18D 04      0.10D 02      0.50D 02
  50       0.35D 04      0.20D 04      0.10D 02      0.10D 03
  51       0.35D 04      0.21D 04      0.10D 02      0.14D 03
  52       0.35D 04      0.24D 04      0.10D 02      0.16D 03
  53       0.35D 04      0.25D 04      0.10D 02      0.18D 03
  54       0.35D 04      0.27D 04      0.10D 02      0.19D 03
  55       0.35D 04      0.30D 04      0.10D 02      0.16D 03
  56       0.35D 04      0.32D 04      0.10D 02      0.15D 03
  57       0.35D 04      0.35D 04      0.10D 02      0.10D 03
  58       0.35D 04      0.37D 04      0.10D 02      0.50D 02
  59       0.35D 04      0.45D 04      0.10D 02      0.00D 00
  60       0.35D 04      0.57D 04      0.10D 02      0.00D 00
  61       0.46D 04      0.00D 00      0.10D 02      0.00D 00
  62       0.46D 04      0.11D 04      0.10D 02      0.00D 00
  63       0.46D 04      0.15D 04      0.10D 02      0.00D 00
  64       0.46D 04      0.18D 04      0.10D 02      0.00D 00
  65       0.46D 04      0.20D 04      0.10D 02      0.65D 02
  66       0.46D 04      0.21D 04      0.10D 02      0.89D 02
  67       0.46D 04      0.24D 04      0.10D 02      0.11D 03
  68       0.46D 04      0.25D 04      0.10D 02      0.15D 03
  69       0.46D 04      0.27D 04      0.10D 02      0.16D 03
  70       0.46D 04      0.30D 04      0.10D 02      0.13D 03
  71       0.46D 04      0.32D 04      0.10D 02      0.98D 02
  72       0.46D 04      0.35D 04      0.10D 02      0.56D 02
  73       0.46D 04      0.37D 04      0.10D 02      0.00D 00
  74       0.46D 04      0.45D 04      0.10D 02      0.00D 00
  75       0.46D 04      0.57D 04      0.10D 02      0.00D 00
  76       0.58D 04      0.00D 00      0.10D 02      0.00D 00
  77       0.58D 04      0.11D 04      0.10D 02      0.00D 00
  78       0.58D 04      0.15D 04      0.10D 02      0.00D 00
  79       0.58D 04      0.18D 04      0.10D 02      0.00D 00
  80       0.58D 04      0.20D 04      0.10D 02      0.50D 02
  81       0.58D 04      0.21D 04      0.10D 02      0.67D 02
  82       0.58D 04      0.24D 04      0.10D 02      0.81D 02
  83       0.58D 04      0.25D 04      0.10D 02      0.93D 02
  84       0.58D 04      0.27D 04      0.10D 02      0.26D 02
  85       0.58D 04      0.30D 04      0.10D 02      0.10D 03
  86       0.58D 04      0.32D 04      0.10D 02      0.00D 00
  87       0.58D 04      0.35D 04      0.10D 02      0.00D 00
  88       0.58D 04      0.37D 04      0.10D 02      0.00D 00
  89       0.58D 04      0.45D 04      0.10D 02      0.00D 00
  90       0.58D 04      0.57D 04      0.10D 02      0.00D 00
  91       0.69D 04      0.00D 00      0.10D 02      0.00D 00
  92       0.69D 04      0.11D 04      0.10D 02      0.00D 00
  93       0.69D 04      0.15D 04      0.10D 02      0.00D 00
  94       0.69D 04      0.18D 04      0.10D 02      0.00D 00
  95       0.69D 04      0.20D 04      0.10D 02      0.50D 02
  96       0.69D 04      0.21D 04      0.10D 02      0.64D 02
  97       0.69D 04      0.24D 04      0.10D 02      0.89D 02
  98       0.69D 04      0.25D 04      0.10D 02      0.11D 03
  99       0.69D 04      0.27D 04      0.10D 02      0.10D 03
 100       0.69D 04      0.30D 04      0.10D 02      0.50D 02
 101       0.69D 04      0.32D 04      0.10D 02      0.00D 00
 102       0.69D 04      0.35D 04      0.10D 02      0.00D 00
 103       0.69D 04      0.37D 04      0.10D 02      0.00D 00
 104       0.69D 04      0.45D 04      0.10D 02      0.00D 00
 105       0.69D 04      0.57D 04      0.10D 02      0.00D 00
 106       0.81D 04      0.00D 00      0.10D 02      0.00D 00
 107       0.81D 04      0.11D 04      0.10D 02      0.00D 00
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108   0 81D 04   0 15D 04   0.10D 02   0.00D 00        168   0 13D 05   0.15D 04   0.10D 02   0 00D 00
109   0 81D 04   0 18D 04   0.10D 02   0 50D 02        169   0 13D 05   0.18D 04   0 10D 02   0 00D 00
110   0 81D 04   0 20D 04   0.10D 02   0.54D 02        170   0.13D 05   0.20D 04   0.10D 02   0 00D 00
111   0 81D 04   0.21D 04   0.10D 02   0 55D 02        171   0 13D 05   0.21D 04   0.10D 02   0 00D 00
112   0 81D 04   0.24D 04   0.10D 02   0.59D 02        172   0 13D 05   0.24D 04   0.10D 02   0 00D 00
113   0 81D 04   0.25D 04   0.10D 02   0.56D 02        173   0 13D 05   0.25D 04   0.10D 02   0 00D 00
114   0 81D 04   0.27D 04   0.10D 02   0.54D 02        174   0 13D 05   0.27D 04   0.10D 02   0 00D 00
115   0 81D 04   0 30D 04   0.10D 02   0.00D 00        175   0.13D 05   0.30D 04   0.10D 02   0 00D 00
116   0 81D 04   0.32D 04   0.10D 02   0.00D 00        176   0.13D 05   0.32D 04   0.10D 02   0 00D 00
117   0 81D 04   0.35D 04   0.10D 02   0.00D 00        177   0 13D 05   0.35D 04   0.10D 02   0 00D 00
118   0 81D 04   0.37D 04   0.10D 02   0.00D 00        178   0.13D 05   0.37D 04   0.10D 02   0 00D 00
119   0 81D 04   0 45D 04   0.10D 02   0.00D 00        179   0 13D 05   0 45D 04   0 10D 02   0 00D 00
120   0 81D 04   0 57D 04   0.10D 02   0 00D 00        180   0 13D 05   0.57D 04   0.10D 02   0 00D 00
121   0 92D 04   0.00D 00   0.10D 02   0.00D 00        181   0 00D 00   0.00D 00   0.10D 02   0 00D 00
122   0 92D 04   0.11D 04   0.10D 02   0.00D 00        182   0.00D 00   0.11D 04   0.10D 02   0.00D 00
123   0 92D 04   0.15D 04   0.10D 02   0.00D 00        183   0 00D 00   0.15D 04   0 10D 02   0 00D 00
124   0.92D 04   0 18D 04   0.10D 02   0.55D 02        184   0 00D 00   0 18D 04   0.10D 02   0 00D 00
125   0 92D 04   0.20D 04   0.10D 02   0.66D 02        185   0 00D 00   0.20D 04   0 10D 02   0 00D 00
126   0 92D 04   0.21D 04   0.10D 02   0.74D 02        186   0 00D 00   0.21D 04   0.10D 02   0 00D 00
127   0 92D 04   0.24D 04   0.10D 02   0.63D 02        187   0 00D 00   0 24D 04   0.10D 02   0 00D 00
128   0 92D 04   0.25D 04   0.10D 02   0.57D 02        188   0 00D 00   0.25D 04   0.10D 02   0 50D 02
129   0 92D 04   0.27D 04   0.10D 02   0 00D 00        189   0 00D 00   0.27D 04   0.10D 02   0.10D 03
130   0 92D 04   0.30D 04   0.10D 02   0.00D 00        190   0 00D 00   0.30D 04   0.10D 02   0 15D 03
131   0.92D 04   0.32D 04   0.10D 02   0.00D 00        191   0 00D 00   0.32D 04   0.10D 02   0 15D 03
132   0 92D 04   0 35D 04   0.10D 02   0.00D 00        192   0 00D 00   0.35D 04   0.10D 02   0 10D 03
133   0.92D 04   0 37D 04   0.10D 02   0.00D 00        193   0.00D 00   0.37D 04   0.10D 02   0 50D 02
134   0 92D 04   0 45D 04   0.10D 02   0 00D 00        194   0 00D 00   0 45D 04   0.10D 02   0 00D 00
135   0.92D 04   0 57D 04   0.10D 02   0.00D 00        195   0.00D 00   0.57D 04   0.10D 02   0 00D 00
136   0 10D 05   0.00D 00   0.10D 02   0.00D 00        196   0 12D 04   0.00D 00   0.10D 02   0 00D 00
137   0.10D 05   0 11D 04   0.10D 02   0 00D 00        197   0.12D 04   0.11D 04   0.10D 02   0 00D 00
138   0.10D 05   0.15D 04   0.10D 02   0.50D 02        198   0 12D 04   0 15D 04   0.10D 02   0 00D 00
139   0 10D 05   0.18D 04   0.10D 02   0.67D 02        199   0 12D 04   0.18D 04   0.10D 02   0 00D 00
140   0 10D 05   0 20D 04   0.10D 02   0.67D 02        200   0 12D 04   0.20D 04   0 10D 02   0.00D 00
141   0 10D 05   0.21D 04   0.10D 02   0.60D 02        201   0.12D 04   0.21D 04   0.10D 02   0.88D 02
142   0 10D 05   0 24D 04   0.10D 02   0.00D 00        202   0 12D 04   0.24D 04   0 10D 02   0 15D 03
143   0 10D 05   0.25D 04   0.10D 02   0.00D 00        203   0 12D 04   0 25D 04   0.10D 02   0 18D 03
144   0 10D 05   0.27D 04   0.10D 02   0.00D 00        204   0 12D 04   0.27D 04   0.10D 02   0 14D 03
145   0 10D 05   0 30D 04   0.10D 02   0.00D 00        205   0 12D 04   0.30D 04   0.10D 02   0 10D 03
146   0 10D 05   0 32D 04   0.10D 02   0.00D 00        206   0.12D 04   0.32D 04   0 10D 02   0 50D 02
147   0 10D 05   0 35D 04   0.10D 02   0.00D 00        207   0 12D 04   0.35D 04   0.10D 02   0 00D 00
148   0 10D 05   0 37D 04   0.10D 02   0.00D 00        208   0 12D 04   0.37D 04   0.10D 02   0 00D 00
149   0 10D 05   0 45D 04   0.10D 02   0.50D 02        209   0.12D 04   0 45D 04   0.10D 02   0 00D 00
150   0 10D 05   0 57D 04   0.10D 02   0.00D 00        210   0 12D 04   0 57D 04   0.10D 02   0 00D 00
151   0 12D 05   0.00D 00   0.10D 02   0.00D 00        211   0 23D 04   0 00D 00   0 10D 02   0 00D 00
152   0 12D 05   0.11D 04   0 10D 02   0.00D 00        212   0 23D 04   0.11D 04   0 10D 02   0 00D 00
153   0 12D 05   0 15D 04   0.10D 02   0 00D 00        213   0 23D 04   0 15D 04   0 10D 02   0 00D 00
154   0 12D 05   0.18D 04   0.10D 02   0.00D 00        214   0 23D 04   0 18D 04   0 10D 02   0 00D 00
155   0 12D 05   0 20D 04   0 10D 02   0.00D 00        215   0 23D 04   0.20D 04   0.10D 02   0 00D 00
156   0 12D 05   0 21D 04   0.10D 02   0.00D 00        216   0 23D 04   0 21D 04   0 10D 02   0 10D 03
157   0 12D 05   0 24D 04   0.10D 02   0.00D 00        217   0 23D 04   0 24D 04   0 10D 02   0 15D 03
158   0 12D 05   0 25D 04   0.10D 02   0.00D 00        218   0 23D 04   0 25D 04   0 10D 02   0 18D 03
159   0 12D 05   0 27D 04   0 10D 02   0.00D 00        219   0 23D 04   0 27D 04   0 10D 02   0 19D 03
160   0 12D 05   0.30D 04   0.10D 02   0.00D 00        220   0 23D 04   0 30D 04   0 10D 02   0 18D 03
161   0 12D 05   0 32D 04   0.10D 02   0.00D 00        221   0 23D 04   0.32D 04   0 10D 02   0 83D 02
162   0 12D 05   0 35D 04   0.10D 02   0.00D 00        222   0.23D 04   0.35D 04   0 10D 02   0 82D 02
163   0 12D 05   0 37D 04   0.10D 02   0 00D 00        223   0 23D 04   0 37D 04   0.10D 02   0 50D 02
164   0 12D 05   0.45D 04   0.10D 02   0 00D 00        224   0 23D 04   0 45D 04   0 10D 02   0 00D 00
165   0 12D 05   0 57D 04   0.10D 02   0.00D 00        225   0 23D 04   0 57D 04   0 10D 02   0 00D 00
166   0 13D 05   0 00D 00   0.10D 02   0.00D 00        226   0 35D 04   0.00D 00   0.10D 02   0 00D 00
167   0 13D 05   0.11D 04   0.10D 02   0.00D 00        227   0 35D 04   0 11D 04   0 10D 02   0.00D 00
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228   0.35D 04   0.15D 04   0.10D 02   0.00D 00      288   0.81D 04   0.15D 04   0.10D 02   0.00D 00
229   0.35D 04   0.18D 04   0.10D 02   0.50D 02      289   0.81D 04   0.18D 04   0.10D 02   0.50D 02
230   0.35D 04   0.20D 04   0.10D 02   0.10D 03      290   0.81D 04   0.20D 04   0.10D 02   0.54D 02
231   0.35D 04   0.21D 04   0.10D 02   0.14D 03      291   0.81D 04   0.21D 04   0.10D 02   0.55D 02
232   0.35D 04   0.24D 04   0.10D 02   0.16D 03      292   0.81D 04   0.24D 04   0.10D 02   0.59D 02
233   0.35D 04   0.25D 04   0.10D 02   0.18D 03      293   0.81D 04   0.25D 04   0.10D 02   0.56D 02
234   0.35D 04   0.27D 04   0.10D 02   0.18D 03      294   0.81D 04   0.27D 04   0.10D 02   0.54D 02
235   0.35D 04   0.30D 04   0.10D 02   0.16D 03      295   0.81D 04   0.30D 04   0.10D 02   0.00D 00
236   0.35D 04   0.32D 04   0.10D 02   0.15D 03      296   0.81D 04   0.32D 04   0.10D 02   0.00D 00
237   0.35D 04   0.35D 04   0.10D 02   0.10D 03      297   0.81D 04   0.35D 04   0.10D 02   0.00D 00
238   0.35D 04   0.37D 04   0.10D 02   0.50D 02      298   0.81D 04   0.37D 04   0.10D 02   0.00D 00
239   0.35D 04   0.45D 04   0.10D 02   0.00D 00      299   0.81D 04   0.45D 04   0.10D 02   0.00D 00
240   0.35D 04   0.57D 04   0.10D 02   0.00D 00      300   0.81D 04   0.57D 04   0.10D 02   0.00D 00
241   0.46D 04   0.00D 00   0.10D 02   0.00D 00      301   0.92D 04   0.00D 00   0.10D 02   0.00D 00
242   0.46D 04   0.11D 04   0.10D 02   0.00D 00      302   0.92D 04   0.11D 04   0.10D 02   0.00D 00
243   0.46D 04   0.15D 04   0.10D 02   0.00D 00      303   0.92D 04   0.15D 04   0.10D 02   0.00D 00
244   0.46D 04   0.18D 04   0.10D 02   0.00D 00      304   0.92D 04   0.18D 04   0.10D 02   0.55D 02
245   0.46D 04   0.20D 04   0.10D 02   0.65D 02      305   0.92D 04   0.20D 04   0.10D 02   0.66D 02
246   0.46D 04   0.21D 04   0.10D 02   0.89D 02      306   0.92D 04   0.21D 04   0.10D 02   0.74D 02
247   0.46D 04   0.24D 04   0.10D 02   0.11D 03      307   0.92D 04   0.24D 04   0.10D 02   0.63D 02
248   0.46D 04   0.25D 04   0.10D 02   0.15D 03      308   0.92D 04   0.25D 04   0.10D 02   0.57D 02
249   0.46D 04   0.27D 04   0.10D 02   0.16D 03      309   0.92D 04   0.27D 04   0.10D 02   0.00D 00
250   0.46D 04   0.30D 04   0.10D 02   0.13D 03      310   0.92D 04   0.30D 04   0.10D 02   0.00D 00
251   0.46D 04   0.32D 04   0.10D 02   0.98D 02      311   0.92D 04   0.32D 04   0.10D 02   0.00D 00
252   0.46D 04   0.35D 04   0.10D 02   0.56D 02      312   0.92D 04   0.35D 04   0.10D 02   0.00D 00
253   0.46D 04   0.37D 04   0.10D 02   0.00D 00      313   0.92D 04   0.37D 04   0.10D 02   0.00D 00
254   0.46D 04   0.45D 04   0.10D 02   0.00D 00      314   0.92D 04   0.45D 04   0.10D 02   0.00D 00
255   0.46D 04   0.57D 04   0.10D 02   0.00D 00      315   0.92D 04   0.57D 04   0.10D 02   0.00D 00
256   0.58D 04   0.00D 00   0.10D 02   0.00D 00      316   0.10D 05   0.00D 00   0.10D 02   0.00D 00
257   0.58D 04   0.11D 04   0.10D 02   0.00D 00      317   0.10D 05   0.11D 04   0.10D 02   0.00D 00
258   0.58D 04   0.15D 04   0.10D 02   0.00D 00      318   0.10D 05   0.15D 04   0.10D 02   0.50D 02
259   0.58D 04   0.18D 04   0.10D 02   0.00D 00      319   0.10D 05   0.18D 04   0.10D 02   0.67D 02
260   0.58D 04   0.20D 04   0.10D 02   0.50D 02      320   0.10D 05   0.20D 04   0.10D 02   0.67D 02
261   0.58D 04   0.21D 04   0.10D 02   0.67D 02      321   0.10D 05   0.21D 04   0.10D 02   0.60D 02
262   0.58D 04   0.24D 04   0.10D 02   0.81D 02      322   0.10D 05   0.24D 04   0.10D 02   0.00D 00
263   0.58D 04   0.25D 04   0.10D 02   0.93D 02      323   0.10D 05   0.25D 04   0.10D 02   0.00D 00
264   0.58D 04   0.27D 04   0.10D 02   0.26D 02      324   0.10D 05   0.27D 04   0.10D 02   0.00D 00
265   0.58D 04   0.30D 04   0.10D 02   0.10D 03      325   0.10D 05   0.30D 04   0.10D 02   0.00D 00
266   0.58D 04   0.32D 04   0.10D 02   0.00D 00      326   0.10D 05   0.32D 04   0.10D 02   0.00D 00
267   0.58D 04   0.35D 04   0.10D 02   0.00D 00      327   0.10D 05   0.35D 04   0.10D 02   0.00D 00
268   0.58D 04   0.37D 04   0.10D 02   0.00D 00      328   0.10D 05   0.37D 04   0.10D 02   0.00D 00
269   0.58D 04   0.45D 04   0.10D 02   0.00D 00      329   0.10D 05   0.45D 04   0.10D 02   0.50D 02
270   0.58D 04   0.57D 04   0.10D 02   0.00D 00      330   0.10D 05   0.57D 04   0.10D 02   0.00D 00
271   0.69D 04   0.00D 00   0.10D 02   0.00D 00      331   0.12D 05   0.00D 00   0.10D 02   0.00D 00
272   0.69D 04   0.11D 04   0.10D 02   0.00D 00      332   0.12D 05   0.11D 04   0.10D 02   0.00D 00
273   0.69D 04   0.15D 04   0.10D 02   0.00D 00      333   0.12D 05   0.15D 04   0.10D 02   0.00D 00
274   0.69D 04   0.18D 04   0.10D 02   0.00D 00      334   0.12D 05   0.18D 04   0.10D 02   0.00D 00
275   0.69D 04   0.20D 04   0.10D 02   0.50D 02      335   0.12D 05   0.20D 04   0.10D 02   0.00D 00
276   0.69D 04   0.21D 04   0.10D 02   0.64D 02      336   0.12D 05   0.21D 04   0.10D 02   0.00D 00
277   0.69D 04   0.24D 04   0.10D 02   0.89D 02      337   0.12D 05   0.24D 04   0.10D 02   0.00D 00
278   0.69D 04   0.25D 04   0.10D 02   0.11D 03      338   0.12D 05   0.25D 04   0.10D 02   0.00D 00
279   0.69D 04   0.27D 04   0.10D 02   0.10D 03      339   0.12D 05   0.27D 04   0.10D 02   0.00D 00
280   0.69D 04   0.30D 04   0.10D 02   0.50D 02      340   0.12D 05   0.30D 04   0.10D 02   0.00D 00
281   0.69D 04   0.32D 04   0.10D 02   0.00D 00      341   0.12D 05   0.32D 04   0.10D 02   0.00D 00
282   0.69D 04   0.35D 04   0.10D 02   0.00D 00      342   0.12D 05   0.35D 04   0.10D 02   0.00D 00
283   0.69D 04   0.37D 04   0.10D 02   0.00D 00      343   0.12D 05   0.37D 04   0.10D 02   0.00D 00
284   0.69D 04   0.45D 04   0.10D 02   0.00D 00      344   0.12D 05   0.45D 04   0.10D 02   0.00D 00
285   0.69D 04   0.57D 04   0.10D 02   0.00D 00      345   0.12D 05   0.57D 04   0.10D 02   0.00D 00
286   0.81D 04   0.00D 00   0.10D 02   0.00D 00      346   0.13D 05   0.00D 00   0.10D 02   0.00D 00
287   0.81D 04   0.11D 04   0.10D 02   0.00D 00      347   0.13D 05   0.11D 04   0.10D 02   0.00D 00
```

348	0 130D 05	0.150D 04	0.100 02	0.000 00
349	0 130D 05	0.180D 04	0.100 02	0.000 00
350	0.130D 05	0.200 04	0.100 02	0.000 00
351	0.130D 05	0.210 04	0.100 02	0.000 00
352	0.130D 05	0.240D 04	0.100 02	0.000 00
353	0.130D 05	0.250 04	0.100 02	0.000 00
354	0.130 05	0.270 04	0.100 02	0.000 00
355	0.130D 05	0.300 04	0.100 02	0.000 00
356	0.130D 05	0.320 04	0.100 02	0.000 00
357	0.130D 05	0.350D 04	0.100 02	0.000 00
358	0.130D 05	0.370 04	0.100 02	0.000 00
359	0.130D 05	0.480 04	0.100 02	0.000 00
360	0.130D 05	0.570 04	0.100 02	0.000 00

NODE-ELEMENT RELATIONSHIP

ELEMS	N1	N2	N3	N4	N5	N6	N7	N8
1	1	2	16	17	181	182	197	196
2	2	3	17	18	182	183	198	197
3	3	4	18	19	183	184	199	198
4	4	5	19	20	184	185	200	199
5	5	6	20	21	185	186	201	200
6	6	7	21	22	186	187	202	201
7	7	8	22	23	187	188	203	202
8	8	9	23	24	188	189	204	203
9	9	10	24	25	189	190	205	204
10	10	11	25	26	190	191	206	205
11	12	13	26	27	191	192	207	206
12	13	14	27	28	192	193	208	207
13	14	15	28	29	193	193	209	208
14	15	6	29	30	194	195	210	209
15	16	17	32	31	196	197	212	211
16	17	18	33	32	197	198	213	212
17	18	19	34	33	198	199	214	213
18	19	20	35	34	199	200	215	214
19	20	21	36	35	200	201	216	215
20	21	22	37	36	201	202	217	216
21	22	23	38	37	202	203	218	217
22	23	24	39	38	203	204	219	218
23	24	25	40	39	204	205	220	219
24	25	26	41	40	205	206	221	220
25	26	27	42	41	206	207	222	221
26	27	28	43	42	207	208	223	222
27	28	29	44	43	208	209	224	223
28	29	30	45	44	209	210	225	224
29	31	32	47	46	211	212	227	226
30	32	33	48	47	212	213	228	227
31	33	34	49	48	213	214	229	228
32	34	35	50	49	214	215	230	229
33	35	36	51	50	215	216	231	230
34	36	37	52	51	216	217	232	231
35	37	38	53	52	217	218	233	232
36	38	39	54	53	218	219	234	233
37	39	40	55	54	219	220	235	234
38	40	41	56	55	220	221	236	235
39	41	42	57	56	221	222	237	236
40	42	43	58	57	222	223	238	237
41	43	44	59	58	223	224	239	238
42	44	45	60	59	224	225	240	239
43	46	47	62	61	226	227	242	241
44	47	48	63	62	227	228	243	242
45	48	49	64	63	228	229	244	243
46	49	50	65	64	229	230	245	244

47	50	51	66	65	230	231	246	245
48	51	52	67	66	231	232	247	246
49	52	53	68	67	232	233	248	247
50	53	54	69	68	233	234	249	248
51	54	55	70	69	234	235	250	249
52	55	56	71	70	235	236	251	250
53	56	57	72	71	236	237	252	251
54	57	58	73	72	237	238	253	252
55	58	59	74	73	238	239	254	253
56	59	60	75	74	239	240	255	254
57	61	62	77	76	241	242	257	256
58	62	63	78	77	242	243	258	257
59	63	64	79	78	243	244	259	258
60	64	65	80	79	244	245	260	259
61	65	66	81	80	245	246	261	260
62	66	67	82	81	246	247	262	261
63	67	68	83	82	247	248	263	262
64	68	69	84	83	248	249	264	263
65	69	70	85	84	249	250	265	264
66	70	71	86	85	250	251	266	265
67	71	72	87	86	251	252	267	266
68	72	73	88	87	252	253	268	267
69	73	74	89	88	253	254	269	268
70	74	75	90	89	254	255	270	269
71	76	77	92	91	256	257	272	271
72	77	78	93	92	257	258	273	272
73	78	79	94	93	258	259	274	273
74	79	80	95	94	259	260	275	274
75	80	81	96	95	260	261	276	275
76	81	82	97	96	261	262	277	276
77	82	83	98	97	262	263	278	277
78	83	84	99	98	263	264	279	278
79	84	85	100	99	264	265	280	279
80	85	86	101	100	265	266	281	280
81	86	87	102	101	266	267	282	281
82	87	88	103	102	267	268	283	282
83	88	89	104	103	268	269	284	283
84	89	90	105	104	269	270	285	284
85	91	92	107	106	271	272	287	286
86	92	93	108	107	272	273	288	287
87	93	94	109	108	273	274	289	288
88	94	95	110	109	274	275	290	289
89	95	96	111	110	275	276	291	290
90	96	97	112	111	276	277	292	291
91	97	98	113	112	277	278	293	292
92	98	99	114	113	278	279	294	293
93	99	100	115	114	279	280	295	294
94	100	101	116	115	280	281	296	295
95	101	102	117	116	281	282	297	296
96	102	103	118	117	282	283	298	297
97	103	104	119	118	283	284	299	298
98	104	105	120	119	284	285	300	299
99	106	107	122	121	286	287	302	301
100	107	108	123	122	287	288	303	302
101	108	109	124	123	288	289	304	303
102	109	110	125	124	289	290	305	304
103	110	111	126	125	290	291	306	305
104	111	112	127	126	291	292	307	306
105	112	113	128	127	292	293	308	307
106	113	114	129	128	293	294	309	308

107	114	115	130	129	294	295	310	309
108	115	116	131	130	295	296	311	310
109	116	117	132	131	296	297	312	311
110	117	118	133	132	297	298	313	312
111	118	119	134	133	298	299	314	313
112	119	120	135	134	299	300	315	314
113	121	122	137	136	301	302	317	316
114	122	123	138	137	302	303	318	317
115	123	124	139	138	303	304	319	318
116	124	125	140	139	304	305	320	319
117	125	126	141	140	305	306	321	340
118	126	127	142	141	306	307	322	341
119	127	128	143	142	307	308	323	342
120	128	129	144	143	308	309	324	343
121	129	130	145	144	309	310	325	344
122	130	131	146	145	310	311	326	345
123	131	132	147	146	311	312	327	346
124	132	133	148	147	312	313	328	347
125	133	134	149	148	313	314	329	348
126	134	135	150	149	314	315	330	349
127	136	137	152	151	316	317	332	331
128	137	138	153	152	317	318	333	332
129	138	139	154	153	318	319	334	333
130	139	140	155	154	319	320	335	334
131	140	141	156	155	320	321	336	335
132	141	142	157	156	321	322	337	336
133	142	143	158	157	322	323	338	337
134	143	144	159	158	323	324	339	338
135	144	145	160	159	324	325	340	339
136	145	146	161	160	325	326	341	340
137	146	147	162	161	326	327	342	341
138	147	148	163	162	327	328	343	342
139	148	149	164	163	328	329	344	343
140	149	150	165	164	329	330	345	344
141	151	152	167	166	331	332	347	346
142	152	153	168	167	332	333	348	347
143	153	154	169	168	333	334	349	348
144	154	155	170	169	334	335	350	349
145	155	156	171	170	335	336	351	350
146	156	157	172	171	336	337	352	351
147	157	158	173	172	337	338	353	352
148	158	159	174	173	338	339	354	353
149	159	160	175	174	339	340	355	354
150	160	161	176	175	340	341	356	355
151	161	162	177	176	341	342	357	356
152	162	163	178	177	342	343	358	357
153	163	164	179	178	343	344	359	358
154	164	165	180	179	344	345	360	359

```
                                FIXED BOUNDARY CONDITIONS

 NODE      ID        NODE      ID        NODE      ID        NODE      ID        NODE      ID

    1      0            2      0            3      0            4      0            5      0
    6      0            7      0            8      0            9      0           10      0
   11      0           12      0           13      0           14      0           15      0
   16      0           30      0           31      0           45      0           46      0
   60      0           61      0           75      0           76      0           90      0
   91      0          105      0          106      0          120      0          121      0
  135      0          136      0          150      0          151      0          165      0
  166      0          167      0          168      0          169      0          170      0
  171      0          172      0          173      0          174      0          175      0
  176      0          177      0          178      0          179      0          180      0
  181      0          182      0          183      0          184      0          185      0
  186      0          187      0          188      0          189      0          190      0
  191      0          192      0          193      0          194      0          195      0
  196      0          210      0          211      0          225      0          226      0
  240      0          241      0          255      0          256      0          270      0
  271      0          285      0          286      0          300      0          301      0
  315      0          316      0          330      0          331      0          345      0
  346      0          347      0          348      0          349      0          350      0
  351      0          352      0          353      0          354      0          355      0
  356      0          357      0          358      0          359      0          360      0


                           MAXIMUM BANDWIDTH = 230 ON ROW NO.°13
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                    OUTPUT FOR THREE-DIMENSIONAL
                    ----------------------------
              GROUNDWATER DISP BY FINITE ELEMENTS METHOD
              ------------------------------------------

               INITIAL CONC DISTRIBUTION AT TIME =   0.000 DAYS

NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS     NODES     CONCS

    1   0 000D 00      2   0.000D 00      3   0.000D 00      4   0.000D 00      5   0.000D 00
    6   0 000D 00      7   0 000D 00      8   0.000D 00      9   0.000D 00     10   0.000D 00
   11   0.000D 00     12   0 000D 00     13   0 000D 00     14   0.000D 00     15   0 000D 00
   16   0 000D 00     17   0.000D 00     18   0.000D 00     19   0.000D 00     20   0.000D 00
   21   0.000D 00     22   0 000D 00     23   0.000D 00     24   0.000D 00     25   0 000D 00
   26   0 000D 00     27   0.000D 00     28   0.000D 00     29   0.000D 00     30   0 000D 00
   31   0.000D 00     32   0.000D 00     33   0.000D 00     34   0.000D 00     35   0.000D 00
   36   0 000D 00     37   0 000D 00     38   0.000D 00     39   0.000D 00     40   0 000D 00
   41   0 000D 00     42   0 000D 00     43   0.000D 00     44   0.000D 00     45   0.000D 00
   46   0 000D 00     47   0 000D 00     48   0.000D 00     49   0.000D 00     50   0 000D 00
   51   0.000D 00     52   0.000D 00     53   0.000D 00     54   0.000D 00     55   0.000D 00
   56   0 000D 00     57   0.000D 00     58   0.000D 00     59   0.000D 00     60   0.000D 00
   61   0 000D 00     62   0.000D 00     63   0.000D 00     64   0.000D 00     65   0 000D 00
   66   0 000D 00     67   0 000D 00     68   0.000D 00     69   0 000D 00     70   0.000D 00
   71   0 000D 00     72   0 000D 00     73   0 000D 00     74   0.000D 00     75   0 000D 00
   76   0 000D 00     77   0 000D 00     78   0.000D 00     79   0.000D 00     80   0.000D 00
   81   0 000D 00     82   0 000D 00     83   0.000D 00     84   0.000D 00     85   0 000D 00
   86   0 000D 00     87   0.000D 00     88   0.000D 00     89   0.000D 00     90   0.000D 00
   91   0.000D 00     92   0.000D 00     93   0.000D 00     94   0.000D 00     95   0 000D 00
   96   0 000D 00     97   0 000D 00     98   0 000D 00     99   0.000D 00    100   0 000D 00
  101   0.000D 00    102   0.000D 00    103   0.000D 00    104   0.000D 00    105   0.000D 00
  106   0 000D 00    107   0 000D 00    108   0 000D 00    109   0.000D 00    110   0 000D 00
  111   0 000D 00    112   0 000D 00    113   0 000D 00    114   0.000D 00    115   0.000D 00
  116   0 000D 00    117   0 000D 00    118   0.000D 00    119   0.000D 00    120   0 000D 00
  121   0 000D 00    122   0.000D 00    123   0.000D 00    124   0.000D 00    125   0 000D 00
  126   0 000D 00    127   0 000D 00    128   0 000D 00    129   0.000D 00    130   0 000D 00
  131   0 000D 00    132   0 000D 00    133   0.000D 00    134   0.000D 00    135   0 000D 00
  136   0 000D 00    137   0.000D 00    138   0.000D 00    139   0.000D 00    140   0 000D 00
  141   0 000D 00    142   0 000D 00    143   0 000D 00    144   0 000D 00    145   0 000D 00
  146   0 000D 00    147   0 000D 00    148   0.000D 00    149   0.000D 00    150   0 000D 00
  151   0 000D 00    152   0 000D 00    153   0 000D 00    154   0.000D 00    155   0.000D 00
  156   0 000D 00    157   0 000D 00    158   0 000D 00    159   0 000D 00    160   0 000D 00
  161   0 000D 00    162   0 000D 00    163   0.000D 00    164   0.000D 00    165   0 000D 00
  166   0 000D 00    167   0 000D 00    168   0 000D 00    169   0.000D 00    170   0 000D 00
  171   0 000D 00    172   0 000D 00    173   0 000D 00    174   0.000D 00    175   0.000D 00
  176   0 000D 00    177   0 000D 00    178   0 000D 00    179   0 000D 00    180   0 000D 00
  181   0 000D 00    182   0 000D 00    183   0 000D 00    184   0.000D 00    185   0 000D 00
  186   0 000D 00    187   0 000D 00    188   0.000D 00    189   0.000D 00    190   0.000D 00
  191   0 000D 00    192   0 000D 00    193   0 000D 00    194   0.000D 00    195   0 000D 00
  196   0 000D 00    197   0 000D 00    198   0 000D 00    199   0.000D 00    200   0 000D 00
  201   0 000D 00    202   0 000D 00    203   0 000D 00    204   0.000D 00    205   0 000D 00
  206   0 000D 00    207   0 000D 00    208   0.000D 00    209   0 000D 00    210   0 000D 00
  211   0 000D 00    212   0.000D 00    213   0.000D 00    214   0.000D 00    215   0.000D 00
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216   0.0000D 00   217   0.0000D 00   218   0.0000D 00   219   0.0000D 00   220   0.0000D 00
221   0.0000D 00   222   0.0000D 00   223   0.0000D 00   224   0.0000D 00   225   0.0000D 00
226   0.0000D 00   227   0.0000D 00   228   0.0000D 00   229   0.0000D 00   230   0.0000D 00
231   0.0000D 00   232   0.0000D 00   233   0.0000D 00   234   0.0000D 00   235   0.0000D 00
236   0.0000D 00   237   0.0000D 00   238   0.0000D 00   239   0.0000D 00   240   0.0000D 00
241   0.0000D 00   242   0.0000D 00   243   0.0000D 00   244   0.0000D 00   245   0.0000D 00
246   0.0000D 00   247   0.0000D 00   248   0.0000D 00   249   0.0000D 00   250   0.0000D 00
251   0.0000D 00   252   0.0000D 00   253   0.0000D 00   254   0.0000D 00   255   0.0000D 00
256   0.0000D 00   257   0.0000D 00   258   0.0000D 00   259   0.0000D 00   260   0.0000D 00
261   0.0000D 00   262   0.0000D 00   263   0.0000D 00   264   0.0000D 00   265   0.0000D 00
266   0.0000D 00   267   0.0000D 00   268   0.0000D 00   269   0.0000D 00   270   0.0000D 00
271   0.0000D 00   272   0.0000D 00   273   0.0000D 00   274   0.0000D 00   275   0.0000D 00
276   0.0000D 00   277   0.0000D 00   278   0.0000D 00   279   0.0000D 00   280   0.0000D 00
281   0.0000D 00   282   0.0000D 00   283   0.0000D 00   284   0.0000D 00   285   0.0000D 00
286   0.0000D 00   287   0.0000D 00   288   0.0000D 00   289   0.0000D 00   290   0.0000D 00
291   0.0000D 00   292   0.0000D 00   293   0.0000D 00   294   0.0000D 00   295   0.0000D 00
296   0.0000D 00   297   0.0000D 00   298   0.0000D 00   299   0.0000D 00   300   0.0000D 00
301   0.0000D 00   302   0.0000D 00   303   0.0000D 00   304   0.0000D 00   305   0.0000D 00
306   0.0000D 00   307   0.0000D 00   308   0.0000D 00   309   0.0000D 00   310   0.0000D 00
311   0.0000D 00   312   0.0000D 00   313   0.0000D 00   314   0.0000D 00   315   0.0000D 00
316   0.0000D 00   317   0.0000D 00   318   0.0000D 00   319   0.0000D 00   320   0.0000D 00
321   0.0000D 00   322   0.0000D 00   323   0.0000D 00   324   0.0000D 00   325   0.0000D 00
326   0.0000D 00   327   0.0000D 00   328   0.0000D 00   329   0.0000D 00   330   0.0000D 00
331   0.0000D 00   332   0.0000D 00   333   0.0000D 00   334   0.0000D 00   335   0.0000D 00
336   0.0000D 00   337   0.0000D 00   338   0.0000D 00   339   0.0000D 00   340   0.0000D 00
341   0.0000D 00   342   0.0000D 00   343   0.0000D 00   344   0.0000D 00   345   0.0000D 00
346   0.0000D 00   347   0.0000D 00   348   0.0000D 00   349   0.0000D 00   350   0.0000D 00
351   0.0000D 00   352   0.0000D 00   353   0.0000D 00   354   0.0000D 00   355   0.0000D 00
356   0.0000D 00   357   0.0000D 00   358   0.0000D 00   359   0.0000D 00   360   0.0000D 00
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                         CONCENIRATION DISTRIBUTION AT TIME = 216 000 DAYS
NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS      NODES      CONCS

    1    0.000D 00        2    0.000D 00        3    0.000D 00        4    0.427D 02        5    0.110D 03
    6    0.122D 03        7    0.200D 03        8    0.188D 03        9    0.160D 03       10    0.902D 02
   11    0.722D 02       12    0.501D 02       13    0.000D 00       14    0.000D 00       15    0.000D 00
   16    0.000D 00       17    0.000D 00       18    0.000D 00       19    0.377D 02       20    0.802D 02
   21    0.125D 03       22    0.149D 03       23    0.171D 03       24    0.171D 03       25    0.126D 03
   26    0.875D 02       27    0.502D 02       28    0.000D 00       29    0.000D 00       30    0.000D 00
   31    0.000D 00       32    0.000D 00       33    0.000D 00       34    0.207D 02       35    0.752D 02
   36    0.133D 03       37    0.150D 03       38    0.170D 03       39    0.210D 03       40    0.170D 03
   41    0.125D 03       42    0.667D 02       43    0.000D 00       44    0.000D 00       45    0.000D 00
   46    0.000D 00       47    0.000D 00       48    0.000D 00       49    0.000D 00       50    0.503D 02
   51    0.100D 03       52    0.150D 03       53    0.170D 03       54    0.220D 03       55    0.220D 03
   56    0.173D 03       57    0.895D 02       58    0.502D 02       59    0.000D 00       60    0.000D 00
   61    0.000D 00       62    0.000D 00       63    0.000D 00       64    0.000D 00       65    0.500D 02
   66    0.722D 02       67    0.113D 03       68    0.150D 03       69    0.180D 03       70    0.220D 03
   71    0.158D 03       72    0.100D 03       73    0.534D 02       74    0.000D 00       75    0.000D 00
   76    0.000D 00       77    0.000D 00       78    0.000D 00       79    0.000D 00       80    0.400D 02
   81    0.609D 02       82    0.781D 02       83    0.100D 03       84    0.125D 03       85    0.123D 03
   86    0.906D 02       87    0.652D 02       88    0.000D 00       89    0.000D 00       90    0.000D 00
   91    0.000D 00       92    0.000D 00       93    0.000D 00       94    0.000D 00       95    0.500D 02
   96    0.625D 02       97    0.813D 02       98    0.100D 03       99    0.846D 02      100    0.654D 02
  101    0.500D 02      102    0.000D 00      103    0.000D 00      104    0.000D 00      105    0.000D 00
  106    0.000D 00      107    0.000D 00      108    0.000D 00      109    0.412D 02      110    0.568D 02
  111    0.614D 02      112    0.682D 02      113    0.750D 02      114    0.623D 02      115    0.501D 02
  116    0.000D 00      117    0.000D 00      118    0.000D 00      119    0.000D 00      120    0.000D 00
  121    0.000D 00      122    0.000D 00      123    0.374D 02      124    0.563D 02      125    0.688D 02
  126    0.750D 02      127    0.688D 02      128    0.587D 02      129    0.000D 00      130    0.000D 00
  131    0.000D 00      132    0.000D 00      133    0.000D 00      134    0.000D 00      135    0.000D 00
  136    0.000D 00      137    0.000D 00      138    0.663D 02      139    0.850D 02      140    0.625D 02
  141    0.542D 02      142    0.420D 02      143    0.000D 00      144    0.000D 00      145    0.000D 00
  146    0.000D 00      147    0.000D 00      148    0.000D 00      149    0.000D 00      150    0.000D 00
  151    0.000D 00      152    0.000D 00      153    0.000D 00      154    0.501D 02      155    0.000D 00
  156    0.000D 00      157    0.000D 00      158    0.000D 00      159    0.000D 00      160    0.000D 00
  161    0.000D 00      162    0.000D 00      163    0.000D 00      164    0.000D 00      165    0.000D 00
  166    0.000D 00      167    0.000D 00      168    0.000D 00      169    0.000D 00      170    0.000D 00
  171    0.000D 00      172    0.000D 00      173    0.000D 00      174    0.000D 00      175    0.000D 00
  176    0.000D 00      177    0.000D 00      178    0.000D 00      179    0.000D 00      180    0.000D 00
  181    0.000D 00      182    0.000D 00      183    0.000D 00      184    0.427D 02      185    0.110D 03
  186    0.122D 03      187    0.200D 03      188    0.188D 03      189    0.160D 03      190    0.902D 02
  191    0.722D 02      192    0.501D 02      193    0.000D 00      194    0.000D 00      195    0.000D 00
  196    0.000D 00      197    0.000D 00      198    0.000D 00      199    0.377D 02      200    0.902D 02
  201    0.125D 03      202    0.149D 03      203    0.171D 03      204    0.171D 03      205    0.126D 03
  206    0.875D 02      207    0.502D 02      208    0.000D 00      209    0.000D 00      210    0.000D 00
  211    0.000D 00      212    0.000D 00      213    0.000D 00      214    0.207D 02      215    0.752D 02
  216    0.133D 03      217    0.150D 03      218    0.170D 03      219    0.210D 03      220    0.170D 03
  221    0.125D 03      222    0.667D 02      223    0.000D 00      224    0.000D 00      225    0.000D 00
  226    0.000D 00      227    0.000D 00      228    0.000D 00      229    0.000D 00      230    0.503D 02
  231    0.100D 03      232    0.150D 03      233    0.170D 03      234    0.220D 03      235    0.220D 03
  236    0.173D 03      237    0.895D 02      238    0.802D 02      239    0.000D 00      240    0.000D 00
  241    0.000D 00      242    0.000D 00      243    0.000D 00      244    0.000D 00      245    0.500D 02
  246    0.722D 02      247    0.113D 03      248    0.150D 03      249    0.180D 03      250    0.220D 03
  251    0.158D 03      252    0.100D 03      253    0.534D 02      254    0.000D 00      255    0.000D 00
  256    0.000D 00      257    0.000D 00      258    0.000D 00      259    0.000D 00      260    0.400D 02
  261    0.609D 02      262    0.781D 02      263    0.100D 03      264    0.125D 03      265    0.123D 03
  266    0.906D 02      267    0.652D 02      268    0.000D 00      269    0.000D 00      270    0.000D 00
```

```
271     0 0000D 00     272     0 0000D 00     273     0.0000 00     274     0.0000 00     275     0 5000D 02
276     0 625D 02      277     0 813D 02      278     0 1000 03     279     0.846D 02     280     0.654D 02
281     0 5000 02      282     0 0000 00      283     0 0000 00     284     0.0000 00     285     0 0000 00
286     0 0000 00      287     0 0000 00      288     0 0000 00     289     0.412D 02     290     0.560D 02
291     0 614D 02      292     0 682D 02      293     0.7500 02     294     0.623D 02     295     0.501D 02
296     0 0000 00      297     0 0000 00      298     0.0000 00     299     0.0000 00     300     0 0000 00
301     0 0000 00      302     0.0000 00      303     0.374D 02     304     0.563D 02     305     0.688D 02
306     0 7500 02      307     0 688D 02      308     0.587D 02     309     0.0000 00     310     0.0000 00
311     0 0000 00      312     0 0000 00      313     0.0000 00     314     0.0000 00     315     0.0000 00
316     0 0000 00      317     0 0000 00      318     0 663D 02     319     0.850D 02     320     0.625D 02
321     0.542D 02      322     0 4200 02      323     0.0000 00     324     0.0000 00     325     0.0000 00
326     0 0000 00      327     0 0000 00      328     0.0000 00     329     0 0000 00     330     0.0000 00
331     0 0000 00      332     0 0000 00      333     0 0000 00     334     0.501D 02     335     0.0000 00
336     0 0000 00      337     0 0000 00      338     0.0000 00     339     0.0000 00     340     0.0000 00
341     0 0000 00      342     0.0000 00      343     0.0000 00     344     0.0000 00     345     0 0000 00
346     0 0000 00      347     0 0000 00      348     0.0000 00     349     0.0000 00     350     0.0000 00
351     0.0000 00      352     0 0000 00      353     0.0000 00     354     0.0000 00     355     0.0000 00
356     0 0000 00      357     0.0000 00      358     0.0000 00     359     0.0000 00     360     0.0000 00
```

```
                    CONCENTRATION DISTRIBUTION AT TIME = 396.000 DAYS
 NODES     CONCS        NODES     CONCS        NODES     CONCS        NODES     CONCS        NODES     CONCS

     1   0.000D 00          2   0.000D 00          3   0.000D 00          4   0.500D 02          5   0 750D 02
     6   0 100D 03          7   0 160D 03          8   0.150D 03          9   0.964D 02         10   0 752D 02
    11   0 563D 02         12   0.383D 02         13   0.000D 00         14   0.000D 00         15   0.000D 00
    16   0 000D 00         17   0.000D 00         18   0.301D 02         19   0.500D 02         20   0.748D 02
    21   0 123D 03         22   0.150D 03         23   0 163D 03         24   0.150D 03         25   0.110D 03
    26   0 833D 02         27   0.500D 02         28   0.000D 00         29   0.000D 00         30   0 000D 00
    31   0 000D 00         32   0.000D 00         33   0 000D 00         34   0.000D 00         35   0.722D 02
    36   0.147D 03         37   0.156D 03         38   0.172D 03         39   0.183D 03         40   0.141D 03
    41   0 105D 03         42   0 751D 02         43   0.201D 02         44   0.000D 00         45   0 000D 00
    46   0 000D 00         47   0.000D 00         48   0 000D 00         49   0.400D 02         50   0 625D 02
    51   0 985D 02         52   0 150D 03         53   0.162D 03         54   0.174D 03         55   0 180D 03
    56   0 164D 03         57   0.100D 03         58   0.663D 02         59   0.000D 00         60   0.000D 00
    61   0 000D 00         62   0.000D 00         63   0.000D 00         64   0.301D 02         65   0 500D C2
    66   0.100D 03         67   0 120D 03         68   0 140D 03         69   0.170D 03         70   0.201D 03
    71   0 172D 03         72   0 127D 03         73   0.753D 02         74   0.000D 00         75   0 000D 00
    76   0.000D 00         77   0.000D 00         78   0.000D 00         79   0.000D 00         80   0 500D 02
    81   0 688D 02         82   0 813D 02         83   0 938D 02         84   0.113D 03         85   0.150D 03
    86   0 120D 03         87   0 875D 02         88   0.594D 02         89   0.000D 00         90   0 000D 00
    91   0 000D 00         92   0 000D 00         93   0 000D 00         94   0.000D 00         95   0 500D 02
    96   0 563D 02         97   0.601D 02         98   0 632D 02         99   0.662D 02        100   0.721D 02
   101   0 643D 02        102   0.582D 02        103   0 400D 02        104   0.000D 00        105   0.000D 00
   106   0 000D 00        107   0 000D 00        108   0.000D 00        109   0.201D 02        110   0 501D 02
   111   0 572D 02        112   0 619D 02        113   0 666D 02        114   0.738D 02        115   0 643D 02
   116   0 548D 02        117   0 213D 02        118   0.000D 00        119   0.000D 00        120   0 000D 00
   121   0 000D 00        122   0 000D 00        123   0.000D 00        124   0.501D 02        125   0 663D 02
   126   0 700D 02        127   0 703D 02        128   0.602D 02        129   0.500D 02        130   0 000D 00
   131   0.000D 00        132   0 000D 00        133   0.000D 00        134   0.000D 00        135   0.000D 00
   136   0 000D 00        137   0 000D 00        138   0.300D 02        139   0.751D 02        140   0.875D 02
   141   0 436D 02        142   0.202D 02        143   0.000D 00        144   0.000D 00        145   0 000D 00
   146   0 000D 00        147   0.000D 00        148   0.000D 00        149   0.000D 00        150   0.000D 00
   151   0 000D 00        152   0.000D 00        153   0.500D 02        154   0 000D 00        155   0.000D 00
   156   0 000D 00        157   0.000D 00        158   0.000D 00        159   0.000D 00        160   0 000D 00
   161   0 000D 00        162   0 000D 00        163   0 000D 00        164   0.000D 00        165   0 000D 00
   166   0 000D 00        167   0 000D 00        168   0.000D 00        169   0.000D 00        170   0.000D 00
   171   0 000D 00        172   0 000D 00        173   0 000D 00        174   0 000D 00        175   0.000D 00
   176   0 000D 00        177   0 000D 00        178   0 000D 00        179   0.000D 00        180   0 000D 00
   181   0 000D 00        182   0 000D 00        183   0.000D 00        184   0.500D 02        185   0 750D 02
   186   0 100D 03        187   0 160D 03        188   0 150D 03        189   0.964D 02        190   0.752D 02
   191   0 563D 02        192   0.383D 02        193   0 000D 00        194   0 000D 00        195   0 000D 00
   196   0 000D 00        197   0 000D 00        198   0 301D 02        199   0.500D 02        200   0 748D 02
   201   0 123D 03        202   0 150D 03        203   0 163D 03        204   0 150D 03        205   0 110D 03
   206   0 833D 02        207   0 500D 02        208   0 000D 00        209   0.000D 00        210   0 000D 00
   211   0 000D 00        212   0 000D 00        213   0 000D 00        214   0.000D 00        215   0 722D 02
   216   0 147D 03        217   0 156D 03        218   0 172D 03        219   0.183D 03        220   0 141D 03
   221   0 105D 03        222   0 751D 02        223   0 201D 02        224   0.000D 00        225   0 000D 00
   226   0 000D 00        227   0 000D 00        228   0 000D 00        229   0 400D 02        230   0 625D 02
   231   0.985D 02        232   0 150D 03        233   0.162D 03        234   0 174D 03        235   0 180D 03
   236   0 164D 03        237   0 100D 03        238   0 663D 02        239   0.000D 00        240   0 000D 00
   241   0 000D 00        242   0 000D 00        243   0.000D 00        244   0.301D 02        245   0 500D 02
   246   0 100D 03        247   0 120D 03        248   0 140D 03        249   0.170D 03        250   0 201D 03
   251   0 172D 03        252   0 127D 03        253   0 753D 02        254   0.000D 00        255   0.000D 00
   256   0 000D 00        257   0 000D 00        258   0.000D 00        259   0.000D 00        260   0.500D 02
   261   0 688D 02        262   0 813D 02        263   0 938D 02        264   0.113D 03        265   0 150D 03
   266   0 120D 03        267   0 875D 02        268   0.594D 02        269   0.000D 00        270   0 000D 00
```

```
271   0 0000 00   272   0 0000 00   273   0 0000 00   274   0.0000 00   275   0 5000 02
276   0 5630 02   277   0 6010 02   278   0 6320 02   279   0 6620 02   280   0 7210 02
281   0 6430 02   282   0.5820 02   283   0 4000 02   284   0.0000 00   285   0 0000 00
286   0 0000 00   287   0 0000 00   288   0.0000 00   289   0.2010 02   290   0 5010 02
291   0 5720 02   292   0 6190 02   293   0.6660 02   294   0.7380 02   295   0 6430 02
296   0 5480 02   297   0 2130 02   298   0 0000 00   299   0.0000 00   300   0 0000 00
301   0 0000 00   302   0 0000 00   303   0 0000 00   304   0.5010 02   305   0 6630 02
306   0 7000 02   307   0 7030 02   308   0 6020 02   309   0.5000 02   310   0.0000 00
311   0 0000 00   312   0 0000 00   313   0.0000 00   314   0.0000 00   315   0 0000 00
316   0 0000 00   317   0.0000 00   318   0.3000 02   319   0.7510 02   320   0 5750 02
321   0 4360 02   322   0.2020 02   323   0.0000 00   324   0.0000 00   325   0.0000 00
326   0 0000 00   327   0 0000 00   328   0.0000 00   329   0.0000 00   330   0 0000 00
331   0 0000 00   332   0 0000 00   333   0.5000 02   334   0.0000 00   335   0.0000 00
336   0 0000 00   337   0.0000 00   338   0.0000 00   339   0.0000 00   340   0 0000 00
341   0 0000 00   342   0 0000 00   343   0.0000 00   344   0.0000 00   345   0 0000 00
346   0 0000 00   347   0 0000 00   348   0 0000 00   349   0.0000 00   350   0.0000 00
351   0 0000 00   352   0 0000 00   353   0.0000 00   354   0.0000 00   355   0 0000 00
356   0 0000 00   357   0 0000 00   358   0.0000 00   359   0.0000 00   360   0 0000 00
```

APPENDIX G

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES

TABLE IV

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 240 HRS., DEPTH: 1 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.120×10^{4}	0.126×10^{3}	0.193×10^{0}	0.641×10^{-5}	0.477×10^{-11}	0.803×10^{-19}	0.305×10^{-28}
Model Solution	0.105×10^{4}	0.111×10^{3}	0.174×10^{0}	0.587×10^{-5}	0.441×10^{-11}	0.775×10^{-19}	0.297×10^{-28}
% Error	12.50	11.9	9.84	8.424	7.547	3.487	2.62
10							
Analytical Solution	0.584×10^{6}	0.534×10^{4}	0.501×10^{1}	0.143×10^{-3}	0.945×10^{-10}	0.161×10^{-17}	0.595×10^{-27}
Model Solution		0.469×10^{4}	0.441×10^{1}	0.131×10^{-3}	0.945×10^{-10}	0.156×10^{-17}	0.580×10^{-27}
% Error	12.32	12.17	11.97	8.39	4.92	3.11	2.52
20							
Analytical Solution	0.188×10^{1}	0.380×10^{-1}	0.629×10^{-4}	0.227×10^{-8}	0.160×10^{-14}	0.251×10^{-22}	0.914×10^{-32}
Model Solution	0.170×10^{1}	0.347×10^{-1}	0.586×10^{-4}	0.259×10^{-8}	0.154×10^{-14}	0.242×10^{-22}	0.893×10^{-32}
% Error	9.57	8.68	6.84	6.50	3.75	3.59	2.30

TABLE V

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 240 HRS., DEPTH: 2 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.869×10^{3}	0.925×10^{2}	0.144×10^{0}	0.483×10^{-5}	0.360×10^{-11}	0.608×10^{-19}	0.232×10^{-28}
Model Solution	0.780×10^{3}	0.834×10^{2}	0.131×10^{0}	0.452×10^{-5}	0.346×10^{-11}	0.590×10^{-19}	0.226×10^{-28}
% Error	10.24	9.84	9.03	6.42	3.90	2.96	2.59
10							
Analytical Solution	0.178×10^{6}	0.380×10^{4}	0.372×10^{1}	0.108×10^{-3}	0.751×10^{-10}	0.122×10^{-17}	0.452×10^{-27}
Model Solution	0.157×10^{6}	0.338×10^{4}	0.335×10^{1}	0.100×10^{-3}	0.715×10^{-10}	0.118×10^{-17}	0.452×10^{-27}
% Error	11.8	11.05	9.95	7.41	4.79	3.28	2.88
20							
Analytical Solution	0.106×10^{1}	0.276×10^{-1}	0.472×10^{-4}	0.171×10^{-8}	0.121×10^{-14}	0.190×10^{-22}	0.693×10^{-32}
Model Solution	0.095×10^{1}	0.249×10^{-1}	0.431×10^{-4}	0.161×10^{-8}	0.116×10^{-14}	0.185×10^{-22}	0.674×10^{-32}
% Error	10.38	9.78	8.69	5.85	4.13	2.63	2.74

TABLE VI

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 240 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.224x10^{3}$	$0.256x10^{2}$	$0.430x10^{-1}$	$0.149x10^{-5}$	$0.113x10^{-11}$	$0.194x10^{-19}$	$0.742x10^{-29}$
Model Solution	$0.203x10^{3}$	$0.232x10^{2}$	$0.392x10^{-1}$	$0.139x10^{-5}$	$0.109x10^{-11}$	$0.189x10^{-19}$	$0.722x10^{-29}$
% Error	9.38	9.38	8.84	6.71	3.54	2.58	1.66
10							
Analytical Solution	$0.132x10^{5}$	$0.907x10^{3}$	$0.108x10^{1}$	$0.330x10^{-4}$	$0.235x10^{-10}$	$0.387x10^{-18}$	$0.145x10^{-27}$
Model Solution	$0.119x10^{5}$	$0.818x10^{3}$	$0.098x10^{1}$	$0.308x10^{-4}$	$0.224x10^{-10}$	$0.376x10^{-18}$	$0.141x10^{-27}$
% Error	9.85	9.81	9.26	6.67	4.68	2.84	2.76
20							
Analytical Solution	$0.897x10^{-1}$	$0.738x10^{-2}$	$0.144x10^{-4}$	$0.528x10^{-9}$	$0.379x10^{-15}$	$0.604x10^{-23}$	$0.222x10^{-32}$
Model Solution	$0.803x10^{-1}$	$0.666x10^{-2}$	$0.132x10^{-4}$	$0.498x10^{-9}$	$0.365x10^{-15}$	$0.588x10^{-23}$	$0.216x10^{-32}$
% Error	10.47	9.76	8.33	5.68	3.69	2.65	2.70

TABLE VII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 480 HRS., DEPTH: 1 M

X (m) → Y (m) ↓	0	10	20	30	40	50	60
5							
Analytical Solution	$0.795\text{x}10^{3}$	$0.316\text{x}10^{3}$	$0.148\text{x}10^{2}$	$0.888\text{x}10^{-1}$	$0.738\text{x}10^{-4}$	$0.875\text{x}10^{-8}$	$0.150\text{x}10^{-12}$
Model Solution	$0.712\text{x}10^{3}$	$0.288\text{x}10^{3}$	$0.137\text{x}10^{2}$	$0.830\text{x}10^{-1}$	$0.718\text{x}10^{-4}$	$0.853\text{x}10^{-8}$	$0.148\text{x}10^{-12}$
% Error	10.44	8.86	7.43	6.53	2.71	2.51	1.33
10							
Analytical Solution	$0.195\text{x}10^{6}$	$0.484\text{x}10^{5}$	$0.890\text{x}10^{3}$	$0.308\text{x}10^{1}$	$0.202\text{x}10^{-2}$	$0.212\text{x}10^{-6}$	$0.338\text{x}10^{-11}$
Model Solution	$0.173\text{x}10^{6}$	$0.429\text{x}10^{5}$	$0.790\text{x}10^{3}$	$0.284\text{x}10^{1}$	$0.194\text{x}10^{-2}$	$0.207\text{x}10^{-6}$	$0.333\text{x}10^{-11}$
% Error	11.36	11.28	11.2	7.79	3.96	2.36	1.48
20							
Analytical Solution	$0.896\text{x}10^{0}$	$0.255\text{x}10^{0}$	$0.609\text{x}10^{-2}$	$0.274\text{x}10^{-4}$	$0.236\text{x}10^{-7}$	$0.300\text{x}10^{-11}$	$0.526\text{x}10^{-16}$
Model Solution	$0.822\text{x}10^{0}$	$0.236\text{x}10^{0}$	$0.573\text{x}10^{-2}$	$0.259\text{x}10^{-4}$	$0.231\text{x}10^{-7}$	$0.294\text{x}10^{-11}$	$0.517\text{x}10^{-16}$
% Error	8.26	7.45	5.91	5.47	2.01	2.0	1.71

TABLE VIII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 480 HRS., DEPTH: 2 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.576×10^{3}	0.230×10^{3}	0.108×10^{2}	0.658×10^{-1}	0.551×10^{-4}	0.657×10^{-8}	0.113×10^{-12}
Model Solution	0.521×10^{-3}	0.209×10^{3}	0.099×10^{2}	0.616×10^{-1}	0.534×10^{-4}	0.644×10^{-8}	0.111×10^{-12}
% Error	9.55	9.13	8.33	6.08	3.09	1.98	1.77
10							
Analytical Solution	0.795×10^{5}	0.229×10^{5}	0.569×10^{3}	0.222×10^{1}	0.149×10^{-2}	0.159×10^{-6}	0.254×10^{-11}
Model Solution	0.714×10^{5}	0.206×10^{5}	0.518×10^{3}	0.207×10^{1}	0.143×10^{-2}	0.156×10^{-6}	0.249×10^{-11}
% Error	10.19	10.04	8.96	6.76	4.03	1.89	1.97
20							
Analytical Solution	0.525×10^{0}	0.155×10^{0}	0.416×10^{-2}	0.202×10^{-4}	0.177×10^{-7}	0.225×10^{-11}	0.396×10^{-16}
Model Solution	0.474×10^{0}	0.141×10^{0}	0.384×10^{-2}	0.192×10^{-4}	0.114×10^{-7}	0.221×10^{-11}	0.388×10^{-16}
% Error	9.71	9.03	7.69	4.95	3.56	1.78	1.80

TABLE IX

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 480 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.150x10^{3}$	$0.608x10^{2}$	$0.296x10^{1}$	$0.189x10^{-1}$	$0.163x10^{-4}$	$0.199x10^{-8}$	$0.347x10^{-13}$
Model Solution	$0.136x10^{3}$	$0.554x10^{2}$	$0.275x10^{1}$	$0.176x10^{-1}$	$0.158x10^{-4}$	$0.195x10^{-8}$	$0.341x10^{-13}$
% Error	9.33	8.88	7.72	5.82	3.07	2.01	1.73
10							
Analytical Solution	$0.814x10^{4}$	$0.296x10^{4}$	$0.114x10^{3}$	$0.573x10^{0}$	$0.425x10^{-3}$	$0.472x10^{-7}$	$0.776x10^{-12}$
Model Solution	0.73[illegible]$x10^{4}$	$0.269x10^{4}$	$0.105x10^{3}$	$0.540x10^{0}$	$0.409x10^{-3}$	$0.463x10^{-7}$	$0.763x10^{-12}$
% Error	9.23	9.12	7.89	5.76	3.76	1.91	1.68
20							
Analytical Solution	$0.555x10^{-1}$	$0.207x10^{-1}$	$0.905x10^{-3}$	$0.575x10^{-5}$	$0.534x10^{-8}$	$0.689x10^{-12}$	$0.122x10^{-16}$
Model Solution	$0.504x10^{-1}$	$0.189x10^{-1}$	$0.835x10^{-3}$	$0.546x10^{-5}$	$0.519x10^{-8}$	$0.678x10^{-12}$	$0.120x10^{-16}$
% Error	9.19	8.70	7.73	4.70	2.81	1.60	1.64

TABLE X

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 720 HRS., DEPTH: 1 M

X (m) → Y (m) ↓	0	10	20	30	40	50	60
5							
Analytical Solution	0.635×10^{3}	0.372×10^{3}	0.539×10^{2}	0.198×10^{1}	0.187×10^{-1}	0.471×10^{-4}	0.318×10^{-7}
Model Solution	0.580×10^{3}	0.343×10^{3}	0.503×10^{2}	0.186×10^{1}	0.182×10^{-1}	0.459×10^{-4}	0.314×10^{-7}
% Error	8.66	7.80	6.68	6.06	2.67	2.55	1.26
10							
Analytical Solution	0.145×10^{6}	0.717×10^{5}	0.662×10^{4}	0.173×10^{3}	0.813×10^{0}	0.154×10^{-2}	0.889×10^{-6}
Model Solution	0.129×10^{6}	0.642×10^{5}	0.594×10^{4}	0.160×10^{3}	0.781×10^{0}	0.151×10^{-2}	0.876×10^{-6}
% Error	10.75	10.46	10.27	7.51	3.94	1.95	1.46
20							
Analytical Solution	0.679×10^{0}	0.351×10^{0}	0.366×10^{-1}	0.894×10^{-3}	0.638×10^{-5}	0.147×10^{-7}	0.102×10^{-10}
Model Solution	0.624×10^{0}	0.327×10^{0}	0.348×10^{-1}	0.849×10^{-3}	0.622×10^{-5}	0.143×10^{-7}	0.100×10^{-10}
% Error	8.10	6.72	4.92	5.03	2.51	2.72	1.96

TABLE XI

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 720 HRS., DEPTH: 2 M

X (m) —> Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.461×10^{3}	0.270×10^{3}	0.394×10^{2}	0.145×10^{1}	0.138×10^{-1}	0.349×10^{-4}	0.237×10^{-7}
Model Solution	0.421×10^{3}	0.248×10^{3}	0.367×10^{2}	0.137×10^{1}	0.134×10^{-1}	0.343×10^{-4}	0.233×10^{-7}
% Error	8.70	8.15	6.85	5.52	2.90	1.72	1.69
10							
Analytical Solution	0.603×10^{5}	0.314×10^{5}	0.333×10^{4}	0.823×10^{2}	0.558×10^{0}	0.112×10^{-2}	0.656×10^{-6}
Model Solution	0.544×10^{5}	0.285×10^{5}	0.306×10^{4}	0.709×10^{2}	0.537×10^{0}	0.110×10^{-2}	0.645×10^{-6}
% Error	9.78	9.24	8.11	6.56	3.76	1.79	1.68
20							
Analytical Solution	0.400×10^{0}	0.290×10^{0}	0.229×10^{-1}	0.599×10^{-3}	0.457×10^{-5}	0.109×10^{-7}	0.760×10^{-11}
Model Solution	0.365×10^{0}	0.193×10^{0}	0.213×10^{-1}	0.570×10^{-3}	0.441×10^{-5}	0.107×10^{-7}	0.748×10^{-11}
% Error	8.75	8.10	6.99	4.84	3.50	1.83	1.58

TABLE XII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 720 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.120\text{x}10^{3}$	$0.710\text{x}10^{2}$	$0.105\text{x}10^{2}$	$0.398\text{x}10^{0}$	$0.390\text{x}10^{-2}$	$0.101\text{x}10^{-4}$	$0.700\text{x}10^{-8}$
Model Solution	$0.109\text{x}10^{3}$	$0.654\text{x}10^{2}$	$0.099\text{x}10^{2}$	$0.374\text{x}10^{0}$	$0.379\text{x}10^{-2}$	$0.099\text{x}10^{-4}$	$0.689\text{x}10^{-8}$
% Error	8.80	7.89	6.67	6.03	2.82	1.98	1.57
10							
Analytical Solution	$0.641\text{x}10^{4}$	$0.362\text{x}10^{4}$	$0.478\text{x}10^{3}$	$0.155\text{x}10^{2}$	$0.130\text{x}10^{0}$	$0.295\text{x}10^{-3}$	$0.185\text{x}10^{-6}$
Model Solution	$0.584\text{x}10^{4}$	$0.333\text{x}10^{4}$	$0.445\text{x}10^{3}$	$0.146\text{x}10^{2}$	$0.125\text{x}10^{0}$	$0.290\text{x}10^{-3}$	$0.182\text{x}10^{-6}$
% Error	8.89	8.10	6.90	5.81	3.85	1.69	1.62
20							
Analytical Solution	$0.438\text{x}10^{-1}$	$0.251\text{x}10^{-1}$	$0.346\text{x}10^{-2}$	$0.123\text{x}10^{-3}$	$0.118\text{x}10^{-5}$	$0.315\text{x}10^{-8}$	$0.228\text{x}10^{-11}$
Model Solution	$0.399\text{x}10^{-1}$	$0.231\text{x}10^{-1}$	$0.323\text{x}10^{-2}$	$0.117\text{x}10^{-3}$	$0.115\text{x}10^{-5}$	$0.390\text{x}10^{-8}$	$0.225\text{x}10^{-11}$
% Error	8.90	7.97	6.65	4.88	2.54	1.59	1.32

TABLE XIII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 960 HRS., DEPTH: 1 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.543×10^{3}	0.382×10^{3}	0.959×10^{2}	0.862×10^{1}	0.280×10^{0}	0.333×10^{-2}	0.164×10^{-4}
Model Solution	0.502×10^{3}	0.356×10^{3}	0.903×10^{2}	0.819×10^{1}	0.275×10^{1}	0.325×10^{-2}	0.144×10^{-4}
% Error	7.55	6.80	5.80	5.75	2.48	2.40	1.37
10							
Analytical Solution	0.120×10^{6}	0.777×10^{5}	0.153×10^{5}	0.956×10^{3}	0.206×10^{2}	0.168×10^{0}	0.558×10^{-3}
Model Solution	0.108×10^{6}	0.702×10^{5}	0.139×10^{5}	0.887×10^{3}	0.198×10^{2}	0.164×10^{0}	0.550×10^{-3}
% Error	1.00	9.65	8.80	7.22	3.88	2.38	1.43
20							
Analytical Solution	0.567×10^{0}	0.375×10^{0}	0.786×10^{-1}	0.542×10^{-2}	0.132×10^{-3}	0.124×10^{-5}	0.476×10^{-8}
Model Solution	0.513×10^{0}	0.353×10^{0}	0.747×10^{-1}	0.519×10^{-2}	0.128×10^{-3}	0.121×10^{-5}	0.470×10^{-8}
% Error	9.52	5.87	4.98	4.07	3.00	2.42	1.26

TABLE XIV

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 960 HRS., DEPTH: 2 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.394\text{x}10^{3}$	$0.278\text{x}10^{3}$	$0.698\text{x}10^{3}$	$0.630\text{x}10^{1}$	$0.206\text{x}10^{0}$	$0.245\text{x}10^{-2}$	$0.108\text{x}10^{-4}$
Model Solution	$0.361\text{x}10^{3}$	$0.258\text{x}10^{3}$	$0.656\text{x}10^{2}$	$0.596\text{x}10^{0}$	$0.200\text{x}10^{0}$	$0.241\text{x}10^{-2}$	$0.106\text{x}10^{-4}$
% Error	8.40	7.19	6.02	5.40	2.91	1.63	1.85
10							
Analytical Solution	$0.504\text{x}10^{5}$	$0.334\text{x}10^{5}$	$0.706\text{x}10^{4}$	$0.493\text{x}10^{3}$	$0.121\text{x}10^{2}$	$0.110\text{x}10^{0}$	$0.392\text{s}10^{-3}$
Model Solution	$0.460\text{x}10^{5}$	$0.306\text{x}10^{5}$	$0.656\text{x}10^{3}$	$0.461\text{x}10^{3}$	$0.116\text{x}10^{2}$	$0.108\text{x}10^{0}$	$0.386\text{x}10^{-3}$
% Error	8.73	8.38	7.08	6.49	4.13	1.82	1.53
20							
Analytical Solution	$0.335\text{x}10^{0}$	$0.223\text{x}10^{0}$	$0.478\text{x}10^{-1}$	$0.342\text{x}10^{-2}$	$0.876\text{x}10^{-4}$	$0.866\text{x}10^{-6}$	$0.346\text{x}10^{-8}$
Model Solution	$0.308\text{x}10^{0}$	$0.207\text{x}10^{0}$	$0.450\text{x}10^{-1}$	$0.326\text{x}10^{-2}$	$0.852\text{x}10^{-4}$	$0.852\text{x}10^{-6}$	$0.341\text{x}10^{-8}$
% Error	8.06	7.17	5.86	4.12	2.74	1.62	1.45

TABLE XV

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 960 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.103x10^3$	$0.729x10^2$	$0.185x10^2$	$0.170x10^1$	$0.564x10^{-1}$	$0.686x10^{-3}$	$0.308x10^{-5}$
Model Solution	$0.095x10^3$	$0.678x10^2$	$0.174x10^2$	$0.160x10^1$	$0.549x10^{-1}$	$0.675x10^{-3}$	$0.303x10^{-5}$
% Error	7.77	7.00	5.95	5.88	2.66	1.60	1.62
10							
Analytical Solution	$0.544x10^4$	$0.376x10^4$	$0.895x10^3$	$0.744x10^2$	$0.221x10^1$	$0.239x10^{-1}$	$0.963x10^{-4}$
Model Solution	$0.503x10^4$	$0.349x10^4$	$0.842x10^3$	$0.703x10^2$	$0.213x10^1$	$0.235x10^{-1}$	$0.949x10^{-4}$
% Error	7.54	7.18	5.92	5.51	3.62	1.67	1.45
20							
Analytical Solution	$0.373x10^{-1}$	$0.260x10^{-1}$	$0.632x10^{-2}$	$0.549x10^{-3}$	$0.175x10^{-4}$	$0.209x10^{-6}$	$0.944x10^{-9}$
Model Solution	$0.345x10^{-1}$	$0.242x10^{-1}$	$0.595x10^{-2}$	$0.524x10^{-3}$	$0.170x10^{-4}$	$0.206x10^{-6}$	$0.931x10^{-9}$
% Error	7.51	6.92	5.85	4.55	2.86	1.44	1.38

TABLE XVI

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 1200 HRS., DEPTH: 1 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.481×10^{3}	0.377×10^{3}	0.131×10^{3}	0.200×10^{2}	0.136×10^{1}	0.410×10^{-1}	0.557×10^{-3}
Model Solution	0.448×10^{3}	0.353×10^{3}	0.125×10^{3}	0.195×10^{2}	0.133×10^{1}	0.405×10^{-1}	0.551×10^{-3}
% Error	6.65	6.37	4.58	2.50	2.21	1.22	1.08
10							
Analytical Solution	0.105×10^{6}	0.708×10^{5}	0.232×10^{5}	0.281×10^{4}	0.142×10^{3}	0.311×10^{1}	0.311×10^{-1}
Model Solution	0.095×10^{6}	0.707×10^{5}	0.212×10^{5}	0.251×10^{4}	0.136×10^{3}	0.304×10^{1}	0.307×10^{-1}
% Error	9.52	9.36	8.62	8.54	4.22	2.25	1.29
20							
Analytical Solution	0.496×10^{0}	0.375×10^{0}	0.116×10^{0}	0.149×10^{-1}	0.816×10^{-3}	0.197×10^{-4}	0.220×10^{-6}
Model Solution	0.464×10^{0}	0.356×10^{0}	0.112×10^{0}	0.144×10^{-1}	0.804×10^{-3}	0.194×10^{-4}	0.217×10^{-6}
% Error	6.45	5.07	3.45	3.35	1.47	1.52	1.37

TABLE XVII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 1200 HRS., DEPTH: 2 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.349×10^{3}	0.274×10^{3}	0.949×10^{2}	0.146×10^{2}	0.991×10^{0}	0.301×10^{-1}	0.410×10^{-3}
Model Solution	0.321×10^{3}	0.254×10^{3}	0.894×10^{2}	$0.131.10^{2}$	0.963×10^{0}	0.295×10^{-1}	0.403×10^{-3}
% Error	8.02	7.21	5.78	5.11	2.83	1.99	1.71
10							
Analytical Solution	0.442×10^{5}	0.334×10^{5}	0.104×10^{5}	0.134×10^{4}	0.743×10^{2}	0.180×10^{1}	0.198×10^{-1}
Model Solution	0.409×10^{5}	0.309×10^{5}	0.097×10^{5}	0.125×10^{4}	0.716×10^{2}	0.177×10^{1}	0.195×10^{-1}
% Error	7.47	7.27	6.73	6.72	3.63	1.67	1.52
20							
Analytical Solution	0.294×10^{0}	0.223×10^{0}	0.698×10^{-1}	0.918×10^{-2}	0.519×10^{-3}	0.131×10^{-4}	0.152×10^{-6}
Model Solution	0.273×10^{0}	0.209×10^{0}	0.660×10^{-1}	0.881×10^{-2}	0.505×10^{-3}	0.129×10^{-4}	0.150×10^{-6}
% Error	7.14	6.28	5.44	4.00	2.70	1.52	1.32

TABLE XVIII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 1. TIME: 1200 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.914×10^{2}	0.718×10^{2}	0.251×10^{2}	0.388×10^{1}	0.268×10^{0}	0.826×10^{-2}	0.114×10^{-3}
Model Solution	0.805×10^{2}	0.670×10^{2}	0.236×10^{2}	0.365×10^{1}	0.261×10^{0}	0.813×10^{-2}	0.112×10^{-3}
% Error	7.00	6.68	5.98	5.92	2.61	1.57	1.75
10							
Analytical Solution	0.481×10^{4}	0.373×10^{4}	0.125×10^{4}	0.181×10^{3}	0.115×10^{2}	0.324×10^{0}	0.409×10^{-2}
Model Solution	0.447×10^{4}	0.348×10^{4}	0.118×10^{4}	0.171×10^{3}	0.111×10^{2}	0.319×10^{0}	0.404×10^{-2}
% Error	7.07	6.70	5.61	5.52	3.48	1.54	1.22
20							
Analytical Solution	0.330×10^{-1}	0.257×10^{-1}	0.871×10^{-2}	0.130×10^{-2}	0.860×10^{-4}	0.257×10^{-5}	0.347×10^{-7}
Model Solution	0.306×10^{-1}	0.240×10^{-1}	0.820×10^{-2}	0.124×10^{-2}	0.838×10^{-4}	0.253×10^{-5}	0.344×10^{-7}
% Error	7.27	6.61	5.86	4.62	2.56	1.56	1.43

TABLE XIX

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 240 HRS., DEPTH: 1 M

X (m) → Y (m) ↓	0	10	20	30	40	50	60
5							
Analytical Solution	$0.117\text{x}10^{4}$	$0.122\text{x}10^{3}$	$0.168\text{x}10^{0}$	$0.625\text{x}10^{-5}$	$0.465\text{x}10^{-11}$	$0.783\text{x}10^{-19}$	$0.297\text{x}10^{-28}$
Model Solution	$0.103\text{x}10^{4}$	$0.108\text{x}10^{3}$	$0.170\text{x}10^{0}$	$0.573\text{x}10^{-5}$	$0.449\text{x}10^{-11}$	$0.756\text{x}10^{-19}$	$0.287\text{x}10^{-28}$
% Error	11.96	11.48	9.57	8.32	3.45	3.44	3.37
10							
Analytical Solution	$0.425\text{x}10^{6}$	$0.518\text{x}10^{4}$	$0.488\text{x}10^{1}$	$0.139\text{x}10^{-3}$	$0.969\text{x}10^{-10}$	$0.157\text{x}10^{-17}$	$0.581\text{x}10^{-27}$
Model Solution	$0.373\text{x}10^{6}$	$0.455\text{x}10^{4}$	$0.430\text{x}10^{1}$	$0.127\text{x}10^{3}$	$0.922\text{x}10^{-10}$	$0.152\text{x}10^{-17}$	$0.562\text{x}10^{-27}$
% Error	12.24	12.16	11.88	8.63	4.85	3.18	3.27
20							
Analytical Solution	$0.174\text{x}10^{1}$	$0.369\text{x}10^{-1}$	$0.613\text{x}10^{-4}$	$0.222\text{x}10^{-8}$	$0.156\text{x}10^{-14}$	$0.245\text{x}10^{-22}$	$0.891\text{x}10^{-32}$
Model Solution	$0.158\text{x}10^{1}$	$0.337\text{x}10^{-1}$	$0.571\text{x}10^{-4}$	$0.208\text{x}10^{-8}$	$0.151\text{x}10^{-14}$	$0.237\text{x}10^{-22}$	$0.871\text{x}10^{-32}$
% Error	9.20	8.67	6.85	6.31	3.21	3.27	2.24

TABLE XX

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 240 HRS., DEPTH: 2 M

X (m) → / Y (m) ↓	0	10	20	30	40	50	60
5							
Analytical Solution	0.864×10^{3}	0.917×10^{2}	0.143×10^{0}	0.478×10^{-5}	0.357×10^{-11}	0.603×10^{-19}	0.229×10^{-28}
Model Solution	0.770×10^{3}	0.825×10^{2}	0.131×10^{0}	0.446×10^{-5}	0.334×10^{-11}	0.586×10^{-19}	0.223×10^{-28}
% Error	10.88	10.03	8.39	6.69	6.44	2.82	2.62
10							
Analytical Solution	0.244×10^{6}	0.377×10^{4}	0.369×10^{1}	0.107×10^{-3}	0.744×10^{-10}	0.121×10^{-17}	0.445×10^{-27}
Model Solution	0.217×10^{6}	0.336×10^{4}	0.333×10^{1}	0.100×10^{-3}	0.709×10^{-10}	0.115×10^{-17}	0.433×10^{-27}
% Error	11.06	10.88	9.76	6.54	4.70	2.48	2.68
20							
Analytical Solution	0.109×10^{1}	0.274×10^{-1}	0.468×10^{-4}	0.170×10^{-8}	0.120×10^{-14}	0.188×10^{-22}	0.687×10^{-32}
Model Solution	0.095×10^{1}	0.247×10^{-1}	0.428×10^{-4}	0.160×10^{-8}	0.117×10^{-14}	0.183×10^{-22}	0.669×10^{-32}
% Error	10.09	9.85	8.55	5.88	2.66	2.66	2.62

TABLE XXI

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 240 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.246×10^{3}	0.278×10^{2}	0.461×10^{-1}	0.159×10^{-5}	0.121×10^{-11}	0.206×10^{-19}	0.788×10^{-29}
Model Solution	0.221×10^{3}	0.251×10^{2}	0.421×10^{1}	0.148×10^{-5}	0.116×10^{-11}	0.200×10^{-19}	0.768×10^{-29}
% Error	10.16	9.71	8.68	6.92	4.13	2.91	2.54
10							
Analytical Solution	0.169×10^{5}	0.101×10^{4}	0.117×10^{1}	0.353×10^{-4}	0.251×10^{-10}	0.411×10^{-18}	0.154×10^{-27}
Model Solution	0.151×10^{5}	0.091×10^{4}	0.107×10^{1}	0.330×10^{-4}	0.239×10^{-10}	0.400×10^{-18}	0.150×10^{-27}
% Error	10.65	9.90	8.55	6.52	4.78	2.68	2.60
20							
Analytical Solution	0.118×10^{0}	0.805×10^{-2}	0.154×10^{-4}	0.564×10^{-9}	0.404×10^{-15}	0.624×10^{-23}	0.236×10^{-32}
Model Solution	0.106×10^{0}	0.727×10^{-2}	0.141×10^{-4}	0.533×10^{-9}	0.389×10^{-15}	0.626×10^{-23}	0.230×10^{-32}
% Error	10.16	9.09	8.44	5.50	3.71	2.54	2.49

TABLE XXII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 480 HRS., DEPTH: 1 M

X (m) —> Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.772×10^{3}	0.307×10^{3}	0.144×10^{2}	-0865×10^{-1}	0.719×10^{-4}	0.853×10^{-8}	0.146×10^{-12}
Model Solution	0.702×10^{3}	0.282×10^{3}	0.133×10^{2}	0.812×10^{-1}	0.703×10^{-4}	0.836×10^{-8}	0.143×10^{-12}
% Error	9.07	8.14	7.64	6.13	2.23	1.99	2.05
10							
Analytical Solution	0.156×10^{6}	0.407×10^{5}	0.833×10^{3}	0.299×10^{1}	0.196×10^{-2}	0.207×10^{-6}	0.330×10^{-11}
Model Solution	0.138×10^{6}	0.362×10^{5}	0.742×10^{3}	0.277×10^{1}	0.189×10^{-2}	0.203×10^{-6}	0.325×10^{-11}
% Error	11.54	11.06	10.92	7.36	3.57	1.93	1.52
20							
Analytical Solution	0.835×10^{0}	0.240×10^{0}	0.585×10^{-2}	0.266×10^{-4}	0.230×10^{-7}	0.292×10^{-11}	0.513×10^{-16}
Model Solution	0.766×10^{0}	0.223×10^{0}	0.553×10^{-2}	0.252×10^{-4}	0.225×10^{-7}	0.286×10^{-11}	0.504×10^{-16}
% Error	8.26	7.08	5.47	5.26	2.17	2.05	1.75

TABLE XXIII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 480 HRS., DEPTH: 2 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.572×10^{3}	0.228×10^{3}	0.107×10^{2}	0.652×10^{-1}	0.546×10^{-4}	0.651×10^{-8}	0.112×10^{-12}
Model Solution	0.517×10^{3}	0.208×10^{3}	0.099×10^{2}	0.609×10^{-1}	0.515×10^{-4}	0.634×10^{-8}	0.109×10^{-12}
% Error	9.61	8.77	7.48	6.59	5.67	2.61	2.50
10							
Analytical Solution	0.946×10^{5}	0.257×10^{5}	0.579×10^{3}	0.221×10^{1}	0.148×10^{-2}	0.157×10^{-6}	0.252×10^{-11}
Model Solution	0.848×10^{5}	0.231×10^{5}	0.528×10^{3}	0.207×10^{1}	0.142×10^{-2}	0.154×10^{-6}	0.248×10^{-11}
% Error	10.36	10.12	8.81	6.33	4.05	1.91	1.59
20							
Analytical Solution	0.534×10^{0}	0.157×10^{0}	0.415×10^{-2}	0.200×10^{-4}	0.175×10^{-7}	0.233×10^{-4}	0.393×10^{-16}
Model Solution	0.484×10^{0}	0.143×10^{0}	0.383×10^{-2}	0.190×10^{-4}	0.171×10^{-7}	0.219×10^{-11}	0.386×10^{-16}
% Error	9.36	8.92	7.71	5.00	2.29	1.79	1.78

TABLE XXIV

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 480 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.164\text{x}10^{3}$	$0.664\text{x}10^{2}$	$0.324\text{x}10^{1}$	$0.204\text{x}10^{-1}$	$0.175\text{x}10^{-4}$	$0.213\text{x}10^{-8}$	$0.371\text{x}10^{-13}$
Model Solution	$0.149\text{x}10^{3}$	$0.605\text{x}10^{2}$	$0.299\text{x}10^{1}$	$0.192\text{x}10^{-1}$	$0.168\text{x}10^{-4}$	$0.209\text{x}10^{-8}$	$0.365\text{x}10^{-13}$
% Error	9.15	8.89	7.72	5.88	4.00	1.88	1.62
10							
Analytical Solution	$0.101\text{x}10^{5}$	$0.355\text{x}10^{4}$	$0.129\text{x}10^{3}$	$0.628\text{x}10^{0}$	$0.460\text{x}10^{-3}$	$0.507\text{x}10^{-7}$	$0.830\text{x}10^{-12}$
Model Solution	$0.091\text{x}10^{5}$	$0.324\text{x}10^{4}$	$0.119\text{x}10^{3}$	$0.594\text{x}10^{0}$	$0.442\text{x}10^{-3}$	$0.497\text{x}10^{-7}$	$0.814\text{x}10^{-12}$
% Error	9.90	8.73	7.75	5.41	3.91	1.97	1.92
20							
Analytical Solution	$0.699\text{x}10^{-1}$	$0.250\text{x}10^{-1}$	$0.101\text{x}10^{-2}$	$0.621\text{x}10^{-5}$	$0.572\text{x}10^{-8}$	$0.737\text{x}10^{-12}$	$0.130\text{x}10^{-16}$
Model Solution	$0.632\text{x}10^{-1}$	$0.228\text{x}10^{-1}$	$0.093\text{x}10^{-2}$	$0.592\text{x}10^{-5}$	$0.556\text{x}10^{-8}$	$0.725\text{x}10^{-12}$	$0.128\text{x}10^{-16}$
% Error	9.59	8.8	7.92	4.67	2.88	1.63	1.54

TABLE XXV

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 720 HRS., DEPTH: 1 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.617\text{x}10^{3}$	$0.361\text{x}10^{3}$	$0.524\text{x}10^{2}$	$0.192\text{x}10^{1}$	$0.182\text{x}10^{-1}$	$0.458\text{x}10^{-4}$	$0.190\text{x}10^{-7}$
Model Solution	$0.565\text{x}10^{3}$	$0.333\text{x}10^{3}$	$0.490\text{x}10^{2}$	$0.181\text{x}10^{1}$	$0.178\text{x}10^{-1}$	$0.447\text{x}10^{-4}$	$0.304\text{x}10^{-7}$
% Error	8.42	7.61	6.49	5.73	2.20	2.40	1.99
10							
Analytical Solution	$0.117\text{x}10^{6}$	$0.587\text{x}10^{5}$	$0.568\text{x}10^{4}$	$0.125\text{x}10^{3}$	$0.777\text{x}10^{0}$	$0.150\text{x}10^{-2}$	$0.865\text{x}20^{-6}$
Model Solution	$0.105\text{x}10^{6}$	$0.526\text{x}10^{5}$	$0.510\text{x}10^{4}$	$0.116\text{x}10^{3}$	$0.747\text{x}10^{0}$	$0.147\text{x}10^{-2}$	$0.854\text{x}10^{-6}$
% Error	10.26	10.39	10.21	7.2	3.86	2.00	1.27
20							
Analvtical Solution	$0.633\text{x}10^{0}$	$0.329\text{x}10^{0}$	$0.346\text{x}10^{-1}$	$0.856\text{x}10^{-3}$	$0.618\text{x}10^{-5}$	$0.143\text{x}10^{-7}$	$0.989\text{x}10^{-11}$
Model Solution	$0.585\text{x}10^{0}$	$0.307\text{x}10^{0}$	$0.329\text{x}10^{-1}$	$0.817\text{x}10^{-3}$	$0.603\text{x}10^{-5}$	$0.140\text{x}10^{-7}$	$0.977\text{x}10^{-11}$
% Error	7.58	6.69	4.91	4.56	2.43	2.10	1.21

TABLE XXVI

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 720 HRS., DEPTH: 2 M

X (m) → Y (m) ↓	0	10	20	30	40	50	60
5							
Analytical Solution	$0.457x10^{3}$	$0.268x10^{3}$	$0.390x10^{2}$	$0.144x10^{1}$	$0.137x10^{-1}$	$0.346x10^{-4}$	$0.235x10^{-7}$
Model Solution	$0.418x10^{3}$	$0.247x10^{3}$	$0.363x10^{2}$	$0.135x10^{1}$	$0.129x10^{-1}$	$0.337x10^{-4}$	$0.230x10^{-7}$
% Error	8.53	7.84	6.92	6.25	5.83	2.60	2.12
10							
Analytical Solution	$0.710x10^{5}$	$0.362x10^{5}$	$0.365x10^{4}$	$0.852x10^{2}$	$0.559x10^{0}$	$0.111x10^{-2}$	$0.650x10^{-6}$
Model Solution	$0.610x10^{5}$	$0.329x10^{5}$	$0.336x10^{4}$	$0.797x10^{2}$	$0.539x10^{0}$	$0.109x10^{-2}$	$0.639x10^{-6}$
% Error	9.86	9.12	7.95	6.46	3.58	1.80	1.69
20							
Analytical Solution	$0.406x10^{0}$	$0.293x10^{0}$	$0.230x10^{-1}$	$0.599x10^{-3}$	$0.454x10^{-5}$	$0.108x10^{-7}$	$0.753x10^{-11}$
Model Solution	$0.373x10^{0}$	$0.197x10^{0}$	$0.215x10^{-1}$	$0.571x10^{-3}$	$0.442x10^{-5}$	$0.906x10^{-7}$	$0.744x10^{-4}$
% Error	8.12	7.51	6.52	4.67	2.54	1.85	1.46

TABLE XXVII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 720 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.132×10^{3}	0.777×10^{2}	0.115×10^{2}	0.433×10^{0}	0.422×10^{-2}	0.109×10^{-4}	0.753×10^{-8}
Model Solution	0.121×10^{3}	0.716×10^{2}	0.107×10^{2}	0.408×10^{0}	0.406×10^{-2}	0.107×10^{-4}	0.742×10^{-8}
% Error	8.33	7.85	6.96	5.77	3.79	1.83	1.46
10							
Analytical Solution	0.789×10^{4}	0.441×10^{4}	0.565×10^{3}	0.177×10^{2}	0.144×10^{0}	0.322×10^{-3}	0.200×10^{-6}
Model Solution	0.722×10^{4}	0.406×10^{4}	0.527×10^{3}	0.167×10^{2}	0.139×10^{0}	0.317×10^{-3}	0.197×10^{-6}
% Error	8.49	7.94	6.73	5.65	3.47	1.55	1.5
20							
Analytical Solution	0.548×10^{-1}	0.308×10^{-1}	0.406×10^{-2}	0.138×10^{-3}	0.129×10^{-5}	0.339×10^{-8}	0.245×10^{-11}
Model Solution	0.500×10^{-1}	0.284×10^{-1}	0.381×10^{-2}	0.132×10^{-3}	0.126×10^{-5}	0.334×10^{-8}	0.242×10^{-11}
% Error	8.76	7.79	6.62	4.35	2.33	1.47	1.22

TABLE XXVIII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 960 HRS., DEPTH: 1 M

X (m) → Y (m) ↓	0	10	20	30	40	50	60
5							
Analytical Solution	0.528×10^{3}	0.372×10^{3}	0.932×10^{2}	0.839×10^{1}	0.273×10^{0}	0.324×10^{-2}	0.142×10^{-4}
Model Solution	0.491×10^{3}	0.348×10^{3}	0.883×10^{2}	0.795×10^{1}	0.268×10^{0}	0.318×10^{-2}	0.140×10^{-4}
% Error	7.00	6.45	5.26	5.24	1.83	1.85	1.41
10							
Analytical Solution	0.969×10^{5}	0.632×10^{5}	0.127×10^{5}	0.827×10^{3}	0.186×10^{2}	0.158×10^{0}	0.537×10^{-3}
Model Solution	0.874×10^{5}	0.574×10^{5}	0.116×10^{5}	0.771×10^{3}	0.180×10^{2}	0.155×10^{0}	0.529×10^{-3}
% Error	9.80	9.16	8.66	6.77	3.23	1.90	1.49
20							
Analytical Solution	0.530×10^{0}	0.351×10^{0}	0.736×10^{-1}	0.513×10^{-2}	0.126×10^{-3}	0.119×10^{-5}	0.461×10^{-8}
Model Solution	0.495×10^{0}	0.332×10^{0}	0.705×10^{-1}	0.490×10^{-2}	0.123×10^{-3}	0.117×10^{-5}	0.453×10^{-8}
% Error	6.60	5.41	4.47	4.48	2.38	1.74	1.68

TABLE XXIX

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 960 HRS., DEPTH: 2 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.391x10^3$	$0.276x10^3$	$0.693x10^2$	$0.625x10^1$	$0.204x10^0$	$0.243x10^{-2}$	$0.107x10^{-4}$
Model Solution	$0.362x10^3$	$0.258x10^3$	$0.651x10^2$	$0.585x10^1$	$0.193x10^0$	$0.235x10^{-2}$	$0.105x10^{-4}$
% Error	7.41	6.52	6.06	5.76	5.39	2.06	1.37
10							
Analytical Solution	$0.592x10^5$	$0.389x10^5$	$0.799x10^4$	$0.536x10^3$	$0.126x10^2$	$0.112x10^0$	$0.391x10^{-3}$
Model Solution	$0.545x10^5$	$0.359x10^5$	$0.743x10^4$	$0.504x10^3$	$0.122x10^2$	$0.111x10^0$	$0.387x10^{-3}$
% Error	7.94	7.71	7.01	5.97	3.17	1.0	0.59
20							
Analytical Solution	$0.340x10^0$	$0.226x10^0$	$0.483x10^{-1}$	$0.344x10^{-2}$	$0.877x10^{-4}$	$0.862x10^{-6}$	$0.343x10^{-8}$
Model Solution	$0.314x10^0$	$0.211x10^0$	$0.454x10^{-1}$	$0.328x10^{-2}$	$0.859x10^{-4}$	$0.846x10^{-6}$	$0.337x10^{-8}$
% Error	7.64	6.64	6.0	4.65	2.05	1.86	1.75

TABLE XXX

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 960 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.113×10^{3}	0.798×10^{2}	0.202×10^{2}	0.185×10^{1}	0.613×10^{-1}	0.744×10^{-3}	0.333×10^{-5}
Model Solution	0.105×10^{3}	0.746×10^{2}	0.190×10^{2}	0.175×10^{1}	0.591×10^{-1}	0.730×10^{-3}	0.327×10^{-5}
% Error	7.08	6.52	5.94	5.41	3.59	1.88	1.80
10							
Analytical Solution	0.669×10^{4}	0.459×10^{4}	0.108×10^{4}	0.874×10^{2}	0.253×10^{1}	0.268×10^{-1}	0.106×10^{-3}
Model Solution	0.617×10^{4}	0.425×10^{4}	0.101×10^{4}	0.826×10^{2}	0.244×10^{1}	0.264×10^{-1}	0.105×10^{-3}
% Error	7.77	7.40	6.48	5.49	3.56	1.49	0.9
20							
Analytical Solution	0.465×10^{-1}	0.321×10^{-1}	0.762×10^{-2}	0.641×10^{-3}	0.198×10^{-4}	0.230×10^{-6}	0.102×10^{-8}
Model Solution	0.431×10^{-1}	0.300×10^{-1}	0.728×10^{-2}	0.612×10^{-3}	0.193×10^{-4}	0.226×10^{-6}	0.101×10^{-8}
% Error	7.31	6.54	5.46	4.52	2.53	1.24	0.98

TABLE XXXI

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 1200 HRS., DEPTH: 1 M

X (m) —> Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	$0.468x10^{3}$	$0.367x10^{3}$	$0.127x10^{3}$	$0.194x10^{2}$	$0.132x10^{1}$	$0.399x10^{-1}$	$0.524x10^{-3}$
Model Solution	$0.435x10^{3}$	$0.344x10^{3}$	$0.120x10^{3}$	$0.184x10^{2}$	$0.136x10^{1}$	$0.335x10^{-1}$	$0.499x10^{-3}$
% Error	7.05	6.27	5.51	5.15	1.75	1.70	1.62
10							
Analytical Solution	$0.846x10^{5}$	$0.633x10^{5}$	$0.191x10^{5}$	$0.237x10^{4}$	$0.123x10^{3}$	$0.280x10^{1}$	$0.290x10^{-1}$
Model Solution	$0.763x10^{5}$	$0.574x10^{5}$	$0.174x10^{5}$	$0.222x10^{4}$	$0.120x10^{3}$	$0.274x10^{1}$	$0.285x10^{-1}$
% Error	9.81	9.32	8.71	6.33	2.44	2.14	1.72
20							
Analytical Solution	$0.464x10^{0}$	$0.350x10^{0}$	$0.109x10^{0}$	$0.140x10^{-1}$	$0.773x10^{-3}$	$0.188x10^{-4}$	$0.292x10^{-6}$
Model Solution	$0.433x10^{0}$	$0.331x10^{0}$	$0.104x10^{0}$	$0.134x10^{-1}$	$0.757x10^{-3}$	$0.195x10^{-4}$	$0.197x10^{-6}$
% Error	6.68	5.43	4.59	4.29	2.07	1.60	1.41

TABLE XXXII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 1200 HRS., DEPTH: 2 M

X (m) → / Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.347×10^{3}	0.272×10^{3}	0.942×10^{2}	0.144×10^{2}	0.983×10^{0}	0.299×10^{-1}	0.407×10^{-3}
Model Solution	0.323×10^{3}	$0.\quad{}^{3}$	0.890×10^{2}	0.137×10^{2}	0.940×10^{0}	0.293×10^{-1}	0.399×10^{-3}
% Error	6.92	6.25	5.52	4.86	4.37	2.00	1.96
10							
Analytical Solution	0.518×10^{5}	0.389×10^{5}	0.119×10^{5}	0.150×10^{4}	0.804×10^{2}	0.189×10^{1}	0.202×10^{-1}
Model Solution	0.476×10^{5}	0.360×10^{5}	0.111×10^{5}	0.140×10^{4}	0.779×10^{2}	0.187×10^{1}	0.200×10^{-1}
% Error	8.11	7.46	6.73	6.66	3.11	1.06	1.0[illegible]
20							
Analytical Solution	0.298×10^{0}	0.226×10^{0}	0.706×10^{-1}	0.926×10^{-2}	0.522×10^{-3}	0.131×10^{-4}	0.151×10^{-6}
Model Solution	0.276×10^{0}	0.211×10^{0}	0.666×10^{-1}	0.889×10^{-2}	0.511×10^{-3}	0.129×10^{-4}	0.149×10^{-5}
% Error	7.38	6.63	5.69	4.06	2.10	1.53	1.32

TABLE XXXIII

ERROR ANALYSIS AT DIFFERENT NODES AND TIMES
CASE 2. TIME: 1200 HRS., DEPTH: 4 M

X (m) → Y ↓ (m)	0	10	20	30	40	50	60
5							
Analytical Solution	0.100×10^{3}	0.787×10^{2}	0.274×10^{2}	0.424×10^{1}	0.292×10^{0}	0.898×10^{-2}	0.124×10^{-3}
Model Solution	0.093×10^{3}	0.740×10^{2}	0.259×10^{2}	0.403×10^{1}	0.282×10^{0}	0.885×10^{-2}	0.122×10^{-3}
% Error	7.00	6.00	5.47	5.00	3.42	1.61	1.45
10							
Analytical Solution	0.590×10^{4}	0.456×10^{4}	0.151×10^{4}	0.216×10^{3}	0.135×10^{2}	0.372×10^{0}	0.461×10^{-2}
Model Solution	0.545×10^{4}	0.423×10^{4}	0.142×10^{4}	0.205×10^{3}	0.131×10^{2}	0.367×10^{0}	0.456×10^{-2}
% Error	7.62	7.24	6.00	5.10	3.00	1.34	1.08
20							
Analytical Solution	0.410×10^{-1}	0.318×10^{-1}	0.106×10^{-1}	0.155×10^{-2}	0.100×10^{-3}	0.291×10^{-5}	0.387×10^{-7}
Model Solution	0.386×10^{-1}	0.300×10^{-1}	0.101×10^{-1}	0.149×10^{-2}	0. $^{-3}$	0.288×10^{-5}	0.344×10^{-7}
% Error	5.85	5.66	4.71	3.87	2.00	1.03	1.03

2

VITA

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