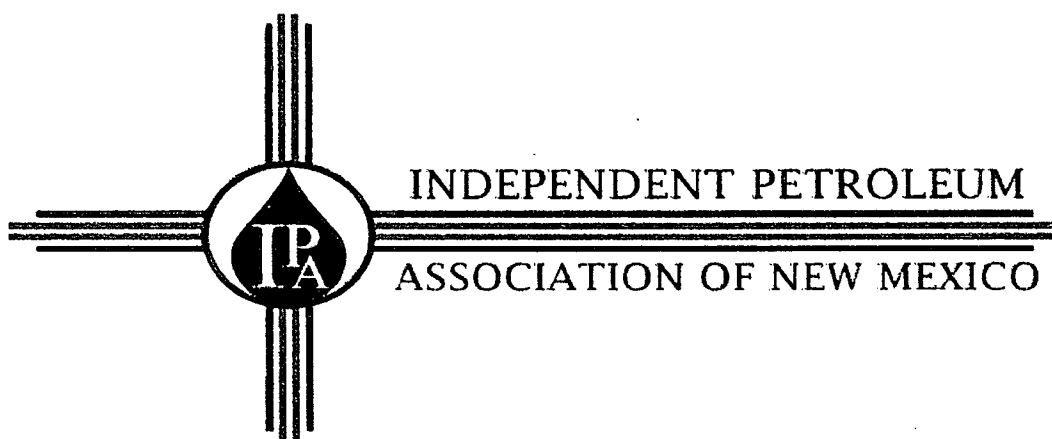




OCD CASE NOS. 14784 AND 14785

IPANM Petition to amend Title 19, Chapter 15,
part 17 (The PIT Rule)

June 27, 2012

IPANM exhibit 18
Modeling - Mullins

Pit Release Modeling

Temporary Drilling Reserve Pit Risk Assessment Modeling for
New Mexico Rule 17 Modifications

Case # 14784 (NMOGA)

Case # 14785 (IPANM)

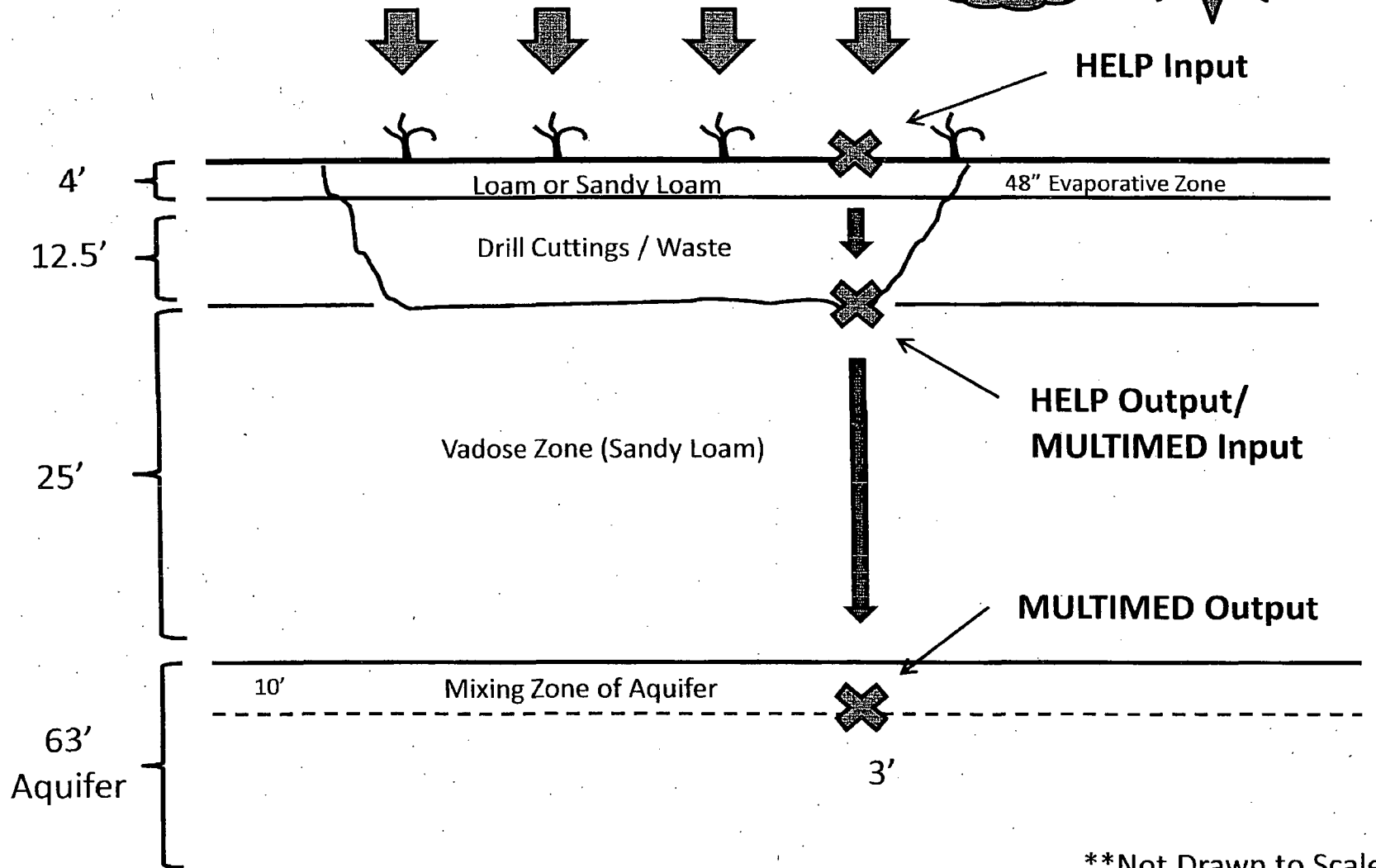
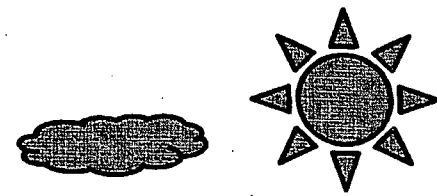
Prepared by Thomas E. Mullins, P.E.

June 25, 2012

Prepared for the Independent Petroleum Association of New Mexico

2012

Conceptual Model



6/25/2012

IPANM - Modeling

**Not Drawn to Scale
2

25' to Ground Water - Low Chloride Focus

48" Evaporative Depth Annual Average Precipitation:	Carlsbad 14.1"	Aztec 10.8"
Elevation (m):	950	1,714
HELP Model Infiltration Rates Liner (mm/yr):	1.53	0.0107
Years until reaching 3' Lateral @ 25' depth:	775	111,367
Years until max Cl:	1,120	> 111,367
Max Cl (mg/l) @ 3' lateral distance:	13.3	0.0006

1

+

AGENCY U. S. ENVIRONMENTAL PROTECTION
EXPOSURE ASSESSMENT
MULTIMEDIA MODEL
MULTIMED (Version 1.01, June 1991)

1

Run options

CARLSBAD, NM - 4' COVER - 25' to GROUNDWATER - 3' LATERAL TO RECEPTOR

20 year ave. - loam cover - good liner - 1K chloride - 10' mixing zone
Chemical simulated is CHLORIDE

Option Chosen Saturated and unsaturated zone models
Run was DETERMIN
Infiltration input by user
Run was transient
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

1

1

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

5

SECARL6.OUT

NP	- Total number of nodal points	240
NMAT	- Number of different porous materials	1
KPROP	- Van Genuchten or Brooks and Corey	1
IMSHGN	- Spatial discretization option	1
NVFLAYR	- Number of layers in flow model	1

OPTIONS CHOSEN

Van Genuchten functional coefficients
 User defined coordinate system
 1

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	7.62	1

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
3.60	-999.	0.100E-10	0.100E+05	cm/hr	CONSTANT
0.250	-999.	0.100E-08	0.990	--	CONSTANT
0.700	-999.	0.000E+00	-999.	m	CONSTANT
7.62	-999.	0.100E-08	-999.	m	CONSTANT

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
0.116	-999.	0.100E-08	1.00	--	CONSTANT

6

SECARL6.OUT

0.000E+00	-999.	Brook and Corey exponent, EN	--	CONSTANT
		0.000E+00 10.0		
0.500E-02	-999.	ALFA coefficient	1/cm	CONSTANT
		0.000E+00 1.00		
1.09	-999.	Van Genuchten exponent, ENN	--	CONSTANT
1		1.00 5.00		

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	1
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	2
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time	0.0
WTFUN	-	Weighting factor	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
 Nondecaying pulse source
 Computer generated times for computing concentrations

1

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
7.62	-999.	Thickness of layer	0.100E-08 -999.	m	CONSTANT
1.00	-999.	Longitudinal dispersivity of layer	0.100E-02 0.100E+05	m	DERIVED
0.000E+00	-999.	Percent organic matter	0.000E+00 100.	--	CONSTANT
1.73	-999.	Bulk density of soil for layer	0.100E-01 5.00	g/cc	CONSTANT
0.000E+00	-999.	Biological decay coefficient	0.000E+00 -999.	1/yr	CONSTANT

1

CHEMICAL SPECIFIC VARIABLES

SECARL6.OUT

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
-999.	-999.	0.000E+00	0.100E+11	1/yr	DERIVED
-999.	-999.	0.000E+00	0.100E+11	1/yr	DERIVED
-999.	-999.	0.000E+00	0.100E+11	1/yr	DERIVED
0.000E+00	-999.	0.000E+00	-999.	1/M-yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.	1/yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.	1/M-yr	CONSTANT
20.0	-999.	0.000E+00	100.	C	CONSTANT
0.000E+00	-999.	0.000E+00	-999.	ml/g	CONSTANT
-999.	-999.	0.000E+00	0.100E+11	--	DERIVED
0.000E+00	-999.	0.000E+00	-999.	1/yr	CONSTANT
0.000E+00	-999.	0.000E+00	10.0	cm2/s	CONSTANT
20.0	-999.	0.000E+00	100.	C	CONSTANT
0.000E+00	-999.	0.000E+00	-999.	g/M	CONSTANT
0.000E+00	-999.	0.100E-08	1.00	--	CONSTANT
0.000E+00	-999.	0.000E+00	100.	mm Hg	CONSTANT
0.000E+00	-999.	0.100E-09	1.00	atm-m ³ /M	CONSTANT
0.000E+00	0.000E+00	0.000E+00	1.00	1/yr	DERIVED
-999.	-999.	0.000E+00	1.00		CONSTANT
-999.	-999.	0.000E+00	1.00		CONSTANT

1

SOURCE SPECIFIC VARIABLES

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
0.153E-02	-999.	0.100E-09	0.100E+11	m/yr	CONSTANT
				m ²	CONSTANT

SECARL6.OUT

167.	-999.	0.100E-01	-999.		
		Duration of pulse		yr	CONSTANT
20.0	-999.	0.100E-08	-999.		
		Spread of contaminant source		m	DERIVED
-999.	-999.	0.100E-08	0.100E+11		
		Recharge rate		m/yr	CONSTANT
0.000E+00	-999.	0.000E+00	0.100E+11		
		Source decay constant		1/yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.		
		Initial concentration at landfill		mg/l	CONSTANT
0.100E+04	-999.	0.000E+00	-999.		
		Length scale of facility		m	DERIVED
-999.	-999.	0.100E-08	0.100E+11		
		Width scale of facility		m	DERIVED
-999.	-999.	0.100E-08	0.100E+11		
		Near field dilution			DERIVED
1.00	0.000E+00	0.000E+00	1.00		
1					

AQUIFER SPECIFIC VARIABLES

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
0.500E-01		Particle diameter		cm	CONSTANT
	-999.	0.100E-08	100.		
0.300		Aquifer porosity		--	CONSTANT
	-999.	0.100E-08	0.990		
1.70		Bulk density		g/cc	CONSTANT
	-999.	0.100E-01	5.00		
21.0		Aquifer thickness		m	CONSTANT
	-999.	0.100E-08	0.100E+06		
3.05		Source thickness (mixing zone depth)		m	CONSTANT
	-999.	0.100E-08	0.100E+06		
30.0		Conductivity (hydraulic)		m/yr	CONSTANT
	-999.	0.100E-06	0.100E+09		
0.100E-02		Gradient (hydraulic)			CONSTANT
	-999.	0.100E-07	-999.		
-999.		Groundwater seepage velocity		m/yr	DERIVED
	-999.	0.100E-09	0.100E+09		
1.00		Retardation coefficient		--	DERIVED
	-999.	1.00	0.100E+09		
-999.		Longitudinal dispersivity		m	FUNCTION OF X
	-999.	0.100E-02	0.100E+05		
-999.		Transverse dispersivity		m	FUNCTION OF X
	-999.	-999.	-999.		
-999.		Vertical dispersivity		m	FUNCTION OF X
	-999.	0.100E-02	0.100E+05		
20.0		Temperature of aquifer		C	CONSTANT
	-999.	0.000E+00	100.		
7.00		pH		--	CONSTANT
	-999.	0.300	14.0		
0.000E+00		Organic carbon content (fraction)			CONSTANT
	-999.	0.100E-05	1.00		
1.00		Well distance from site		m	CONSTANT
	-999.	1.00	-999.		

9

SECARL6.OUT

	Angle off center		degree	CONSTANT
0.000E+00	-999.	0.000E+00	360.	
	well vertical distance		m	CONSTANT
0.000E+00	-999.	0.000E+00	1.00	

1

TIME	CONCENTRATION
0.700E+03	0.00000E+00
0.725E+03	0.00000E+00
0.750E+03	0.75202E+00
0.775E+03	0.23361E+01
0.800E+03	0.36184E+01
0.825E+03	0.48730E+01
0.850E+03	0.56166E+01
0.875E+03	0.72876E+01
0.900E+03	0.85907E+01
0.925E+03	0.98257E+01
0.950E+03	0.10472E+02
0.975E+03	0.11482E+02
0.100E+04	0.12312E+02
0.102E+04	0.12629E+02
0.105E+04	0.13109E+02
0.107E+04	0.13307E+02
0.110E+04	0.13376E+02
0.112E+04	0.13395E+02
0.115E+04	0.13141E+02
0.117E+04	0.12941E+02

AZTEC1.OUT

1

AGENCY U. S. ENVIRONMENTAL PROTECTION
EXPOSURE ASSESSMENT
MULTIMEDIA MODEL
MULTIMED (Version 1.01, June 1991)

1

Run options

AZTEC, NM - 4' COVER - 25' TO GROUNDWATER - 3' TO RECEPTOR

20 yr pulse. - loam cover - good liner - 1K chloride - 10' mixing zone
Chemical simulated is CHLORIDE

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN
Infiltration input by user	
Run was transient	
Reject runs if Y coordinate outside plume	
Do not reject runs if Z coordinate outside plume	
Gaussian source used in saturated zone model	

1

1

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)
NP - Total number of nodal points

240

AZTEC1.OUT

NMAT	- Number of different porous materials	1
KPROP	- Van Genuchten or Brooks and Corey	1
IMSHGN	- Spatial discretization option	1
NVFLAYR	- Number of layers in flow model	1

OPTIONS CHOSEN

 Van Genuchten functional coefficients
 User defined coordinate system

1

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	7.62	1

DATA FOR MATERIAL 1

 VADOSE ZONE MATERIAL VARIABLES

PARAMETERS				VARIABLE NAME LIMITS	UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX			
3.60	-999.	0.100E-10	0.100E+05	Saturated hydraulic conductivity	cm/hr	CONSTANT
0.250	-999.	0.100E-08	0.990	Unsaturated zone porosity	--	CONSTANT
0.700	-999.	0.000E+00	-999.	Air entry pressure head	m	CONSTANT
7.62	-999.	0.100E-08	-999.	Depth of the unsaturated zone	m	CONSTANT

DATA FOR MATERIAL 1

 VADOSE ZONE FUNCTION VARIABLES

PARAMETERS				VARIABLE NAME LIMITS	UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX			
0.116	-999.	0.100E-08	1.00	Residual water content	--	CONSTANT
				Brook and Corey exponent, EN	--	CONSTANT

AZTEC1.OUT
 0.000E+00 -999. 0.000E+00 10.0
 ALFA coefficient 1/cm CONSTANT
 0.500E-02 -999. 0.000E+00 1.00
 Van Genuchten exponent, ENN -- CONSTANT
 1.09 -999. 1.00 5.00
 1

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY - Number of different layers used 1
 NTSTPS - Number of time values concentration calc 40
 DUMMY - Not presently used 1
 ISOL - Type of scheme used in unsaturated zone 1
 N - Stehfest terms or number of increments 18
 NTEL - Points in Lagrangian interpolation 3
 NGPTS - Number of Gauss points 104
 NIT - Convolution integral segments 2
 IBOUND - Type of boundary condition 2
 ITSGEN - Time values generated or input 1
 TMAX - Max simulation time -- 0.0
 WTFUN - weighting factor -- 1.2

OPTIONS CHOSEN

 Stehfest numerical inversion algorithm
 Nondecaying pulse source
 Computer generated times for computing concentrations
 1

DATA FOR LAYER 1

 VADOSE TRANSPORT VARIABLES

PARAMETERS		VARIABLE NAME LIMITS	UNITS	DISTRIBUTION
MEAN	STD DEV	MIN MAX		

7.62	-999.	Thickness of layer 0.100E-08 -999.	m	CONSTANT
1.00	-999.	Longitudinal dispersivity of layer 0.100E-02 0.100E+05	m	DERIVED
0.000E+00	-999.	Percent organic matter 0.000E+00 100.	--	CONSTANT
1.73	-999.	Bulk density of soil for layer 0.100E-01 5.00	g/cc	CONSTANT
0.000E+00	-999.	Biological decay coefficient 0.000E+00 -999.	1/yr	CONSTANT
1				

CHEMICAL SPECIFIC VARIABLES

AZTEC1.OUT					UNITS	DISTRIBUTION
PARAMETERS		VARIABLE NAME LIMITS				
MEAN	STD DEV	MIN	MAX			

		Solid phase decay coefficient			1/yr	DERIVED
-999.	-999.	0.000E+00	0.100E+11			
		Dissolved phase decay coefficient			1/yr	DERIVED
-999.	-999.	0.000E+00	0.100E+11			
		Overall chemical decay coefficient			1/yr	DERIVED
-999.	-999.	0.000E+00	0.100E+11			
		Acid catalyzed hydrolysis rate			1/M-yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.			
		Neutral hydrolysis rate constant			1/yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.			
		Base catalyzed hydrolysis rate			1/M-yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.			
		Reference temperature			C	CONSTANT
20.0	-999.	0.000E+00	100.			
		Normalized distribution coefficient			ml/g	CONSTANT
0.000E+00	-999.	0.000E+00	-999.			
		Distribution coefficient			--	DERIVED
-999.	-999.	0.000E+00	0.100E+11			
		Biodegradation coefficient (sat. zone)			1/yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.			
		Air diffusion coefficient			cm2/s	CONSTANT
0.000E+00	-999.	0.000E+00	10.0			
		Reference temperature for air diffusion			C	CONSTANT
20.0	-999.	0.000E+00	100.			
		Molecular weight			g/M	CONSTANT
0.000E+00	-999.	0.000E+00	-999.			
		Mole fraction of solute			--	CONSTANT
0.000E+00	-999.	0.100E-08	1.00			
		Vapor pressure of solute			mm Hg	CONSTANT
0.000E+00	-999.	0.000E+00	100.			
		Henry's law constant			atm-m^3/M	CONSTANT
0.000E+00	-999.	0.100E-09	1.00			
		Overall 1st order decay sat. zone			1/yr	DERIVED
0.000E+00	0.000E+00	0.000E+00	1.00			
		Not currently used				CONSTANT
-999.	-999.	0.000E+00	1.00			
		Not currently used				CONSTANT
-999.	-999.	0.000E+00	1.00			
1						

SOURCE SPECIFIC VARIABLES

PARAMETERS				VARIABLE NAME LIMITS	UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX			

Infiltration rate					m/yr	CONSTANT
0.106E-04	-999.	0.100E-09	0.100E+11			
Area of waste disposal unit					m^2	CONSTANT
167.	-999.	0.100E-01	-999.			

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AZTEC1.OUT

20.0	-999.	0.100E-08	-999.	yr	CONSTANT
		Spread of contaminant source		m	DERIVED
-999.	-999.	0.100E-08	0.100E+11		
		Recharge rate		m/yr	CONSTANT
0.000E+00	-999.	0.000E+00	0.100E+11		
		Source decay constant		1/yr	CONSTANT
0.000E+00	-999.	0.000E+00	-999.		
		Initial concentration at landfill		mg/l	CONSTANT
0.100E+04	-999.	0.000E+00	-999.		
		Length scale of facility		m	DERIVED
-999.	-999.	0.100E-08	0.100E+11		
		Width scale of facility		m	DERIVED
-999.	-999.	0.100E-08	0.100E+11		
		Near field dilution			DERIVED
1.00	0.000E+00	0.000E+00	1.00		
1					

AQUIFER SPECIFIC VARIABLES

PARAMETERS		VARIABLE NAME LIMITS		UNITS	DISTRIBUTION
MEAN	STD DEV	MIN	MAX		
0.500E-01	-999.	0.100E-08	100.	cm	CONSTANT
		Aquifer porosity		--	CONSTANT
0.300	-999.	0.100E-08	0.990		
		Bulk density		g/cc	CONSTANT
1.70	-999.	0.100E-01	5.00		
		Aquifer thickness		m	CONSTANT
21.0	-999.	0.100E-08	0.100E+06		
		Source thickness (mixing zone depth)		m	CONSTANT
3.05	-999.	0.100E-08	0.100E+06		
		Conductivity (hydraulic)		m/yr	CONSTANT
30.0	-999.	0.100E-06	0.100E+09		
		Gradient (hydraulic)			CONSTANT
0.100E-02	-999.	0.100E-07	-999.		
		Groundwater seepage velocity		m/yr	DERIVED
-999.	-999.	0.100E-09	0.100E+09		
		Retardation coefficient		--	DERIVED
1.00	-999.	1.00	0.100E+09		
		Longitudinal dispersivity		m	FUNCTION OF X
-999.	-999.	0.100E-02	0.100E+05		
		Transverse dispersivity		m	FUNCTION OF X
-999.	-999.	-999.	-999.		
		Vertical dispersivity		m	FUNCTION OF X
-999.	-999.	0.100E-02	0.100E+05		
		Temperature of aquifer		C	CONSTANT
20.0	-999.	0.000E+00	100.		
		pH		--	CONSTANT
7.00	-999.	0.300	14.0		
		Organic carbon content (fraction)			CONSTANT
0.000E+00	-999.	0.100E-05	1.00		
		Well distance from site		m	CONSTANT
1.00	-999.	1.00	-999.		
		Angle off center		degree	CONSTANT

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AZTEC1.OUT
0.000E+00 -999. 0.000E+00 360.
well vertical distance m CONSTANT
0.000E+00 -999. 0.000E+00 1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.6222E-03

PEAK CONCENTRATION