Transparency: Shedding Light on PA Modeling

John Tauxe

Neptune and Company

Presentation Topics

Transparency is important in...

- Coding
  - User Interface
    - Communicating Concepts
      - Documentation
        - Decision Making

Transparency in Coding

This is opaque code:

```
FUNCTION BESSI(N,X)
      PARAMETER(IACC=40,BIGNO=1.0E10,BIGNI=1.0E-10)
      IF (N.LT.2) PAUSE 'bad argument N in BESSI'
      TOX=2.0/X
      BIP=0.0
      BI=1.0
      BESSI=0.
      M=2*((N+INT(SQRT(FLOAT(IACC*N)))))
      DO 11 J=M,1,-1
        BIM=BIP+FLOAT(J)*TOX*BI
        BIP=BI
        BI=BIM
        IF (ABS(BI).GT.BIGNO) THEN
          BESSI=BESSI*BIGNI
          BI=BI*BIGNI
          BIP=BIP*BIGNI
        ENDIF
        IF (J.EQ.N) BESSI=BIP
11    CONTINUE
      BESSI=BESSI*BESSI0(X)/BI
      RETURN
      END
```

with apologies to *Numerical Recipes*

```
#include <math.h>
#define ACC 40.0
#define BIGNO 1.0e10
#define BIGNI 1.0e-10
float bessi(n,x)
int n;
float x;
{
    int j;
    float bi,bim,bip,tox,ans;
    float bessi0();
    void nrerror();
    if (n < 2) nrerror("Index n less than 2 in BESSI");
    if (x == 0.0)
        return 0.0;
    else {
        tox=2.0/fabs(x);
        bip=ans=0.0;
        bi=1.0;
        for (j=2*(n+(int) sqrt(ACC*n));j>0;j--) {
            bim=bip+j*tox*bi;
            bip=bi;
            bi=bim;
            if (fabs(bi) > BIGNO) {
                ans *= BIGNI;
                bi *= BIGNI;
                bip *= BIGNI;
            }
            if (j == n) ans=bip;
        }
        ans *= bessi0(x)/bi;
        return  x < 0.0 && n%2 == 1 ? -ans : ans;
    }
}
#undef ACC
#undef BIGNO
#undef BIGNI
```

Transparency in Coding

This is commented code: Remember ASCII art?

```
{
/* dfWinbox and dfCellSize are defined globally             */
double dfX, dfY;            /* f.p. index to cell           */
double dfDenominator;       /* temp variable                */
int    iX, iY;              /* cell index number            */
int    nxLower, nyLower;    /* index to lower bounding cell */
int    nxUpper, nyUpper;    /* index to upper bounding cell */
POINT  ptLower, ptUpper;    /* corner points bounding cell  */
float  fTemp;               /* temporary variable           */


/* I was forced to add this since for some reason nCols and nRows
 * are not consistently read properly above using PrivateWindowCols
 * and PrivateWindowCols. */
nCols = (int)( ( Xmax( dfWinbox ) - Xmin( dfWinbox ) ) / dfCellSize );
nRows = (int)( ( Ymax( dfWinbox ) - Ymin( dfWinbox ) ) / dfCellSize );

/* Determine which cell contains the point ppt. */
/* First, work with the GRID cells, to subdivide later. */

/* Find cell index number of Lower bounding cell. */
dfX = ( ppt->x - Xmin( dfWinbox ) ) / dfCellSize;
iX  = (int)dfX;         /* truncation to integer */

dfY = ( Ymax( dfWinbox ) - ppt->y ) / dfCellSize;
iY  = (int)dfY;         /* truncation to integer */

pcell->iX = iX;
pcell->iY = iY;
```

```
*   So for the purposes of this DarcyTrack function, the elemental
*      cell over which calculations are done must be a quarter
*      of the original GRID cells, to ensure uniform properties
*      over the cell area:
*
*          +---|---+---|---+---|---+---|---+
*          |   |   |   |   |   |   |   |   |
*          |---O---|---O---|---O---|---O---|
*          |   |   |   |   |   |   |   |   |
*          +---|---+---|---+---|---+---|---+
*          |   |   |   |   |   |   |   |   |
*          |---O---|---O---|---O---|---O---|
*          |   |   |   |   |   |   |   |   |
*          +---|---+---|---+---|---+---|---+
*
*              |-------|           |---|
*             cell size          edge size
*
*   Notes on orientation: (This is a square GRID cell)
*
*     Ymax +-----------------------+       pt.x and pt.y are in real
*          |                       |           coordinates
*          |                       |
*          |                       |       Xmin, Xmax, Ymin, Ymax are
*          |                       |           in real coordinates,
*          |                       |           and are the limits of
*     pt.y + iY       + pt         |           the grid, as stored
*          |                       |           in the global
*          |                       |           variable dfWinbox
*          |                       |
*          |                       |       iX and iY are cell column
*          |          iX           |           (left to right) and
*     Ymin +----------+------------+           row (top to bottom)
*        Xmin        pt.x        Xmax
*
```

Transparency in the User Interface

Old school UI design: Text

```
A sample parameter file.
0
30
100
0
4
100
2
10
1
0.005
10
1
0.01
1
0.1
0.01
1.0
1
0.5
0.01
2
0.01
0.005
20
0.3
```

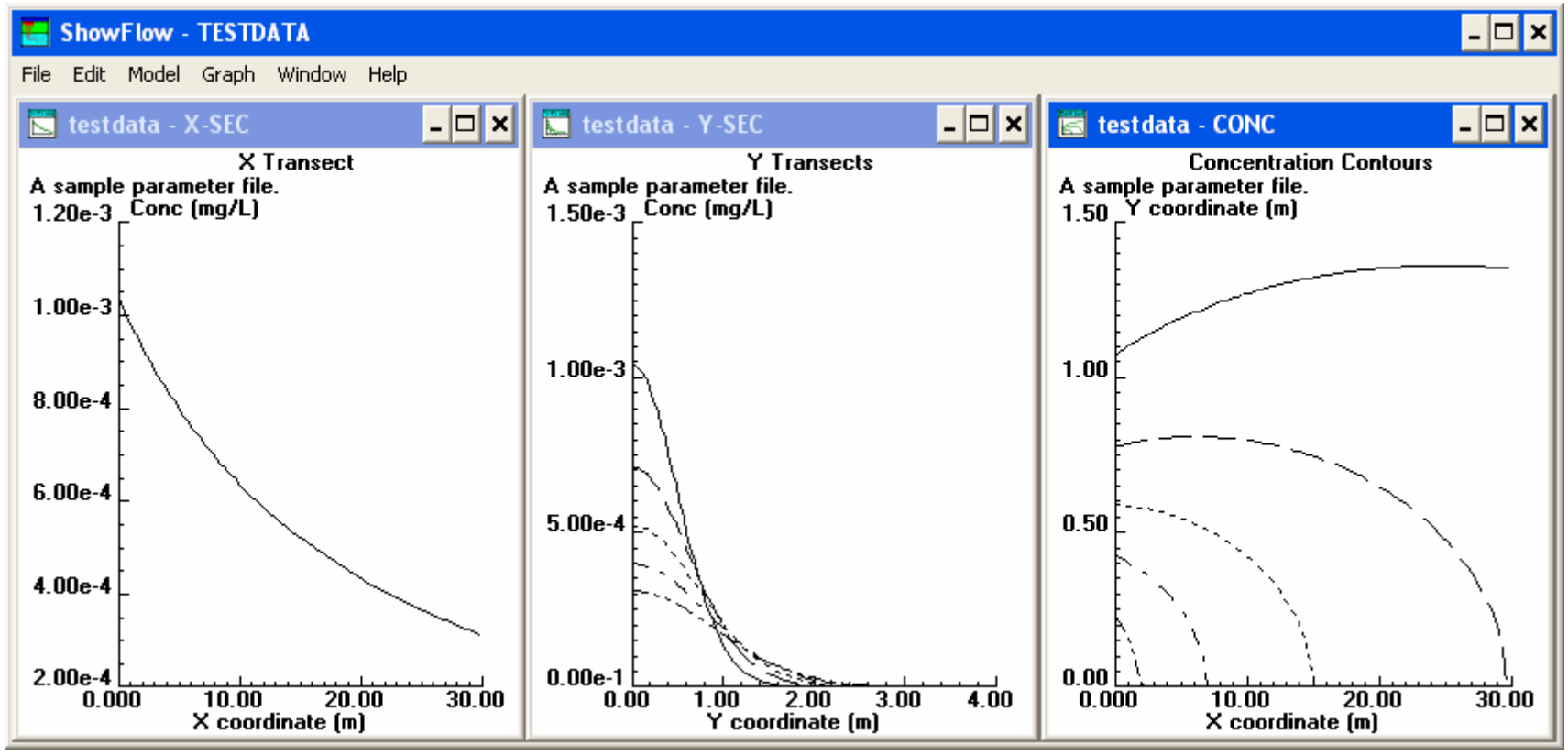
```
C:\>
C:\>EDIT MODEL.DAT
C:\>RUN MODEL.EXE
C:\>TYPE MODEL.OUT

    0.00E+000 1.07E+000 7.76E-001 5.89E-001 4.22E-001 2.30E-001
    5.05E-001 1.09E+000 7.81E-001 5.87E-001 4.12E-001 1.98E-001
    1.01E+000 1.10E+000 7.86E-001 5.85E-001 4.01E-001 1.59E-001
    1.52E+000 1.11E+000 7.91E-001 5.82E-001 3.88E-001 1.02E-001
    2.02E+000 1.13E+000 7.94E-001 5.79E-001 3.75E-001 0.00E+000
    2.53E+000 1.14E+000 7.98E-001 5.75E-001 3.59E-001 0.00E+000
    3.03E+000 1.15E+000 8.01E-001 5.70E-001 3.42E-001 0.00E+000
    3.54E+000 1.16E+000 8.03E-001 5.65E-001 3.22E-001 0.00E+000
    4.04E+000 1.17E+000 8.05E-001 5.58E-001 3.00E-001 0.00E+000
    4.55E+000 1.18E+000 8.07E-001 5.52E-001 2.76E-001 0.00E+000
    5.05E+000 1.19E+000 8.08E-001 5.44E-001 2.47E-001 0.00E+000
    5.56E+000 1.20E+000 8.08E-001 5.36E-001 2.13E-001 0.00E+000
    6.06E+000 1.21E+000 8.09E-001 5.26E-001 1.70E-001 0.00E+000
    6.57E+000 1.22E+000 8.09E-001 5.17E-001 1.09E-001 0.00E+000
    7.07E+000 1.23E+000 8.08E-001 5.06E-001 0.00E+000 0.00E+000
    7.58E+000 1.24E+000 8.07E-001 4.94E-001 0.00E+000 0.00E+000
    8.08E+000 1.24E+000 8.06E-001 4.81E-001 0.00E+000 0.00E+000
    8.59E+000 1.25E+000 8.04E-001 4.68E-001 0.00E+000 0.00E+000
    9.09E+000 1.26E+000 8.02E-001 4.53E-001 0.00E+000 0.00E+000
    9.60E+000 1.27E+000 7.99E-001 4.37E-001 0.00E+000 0.00E+000
    1.01E+001 1.27E+000 7.96E-001 4.20E-001 0.00E+000 0.00E+000
    1.06E+001 1.28E+000 7.93E-001 4.01E-001 0.00E+000 0.00E+000
    1.11E+001 1.28E+000 7.89E-001 3.80E-001 0.00E+000 0.00E+000
    1.16E+001 1.29E+000 7.85E-001 3.57E-001 0.00E+000 0.00E+000
    1.21E+001 1.30E+000 7.80E-001 3.32E-001 0.00E+000 0.00E+000
    1.26E+001 1.30E+000 7.75E-001 3.04E-001 0.00E+000 0.00E+000
    1.31E+001 1.31E+000 7.70E-001 2.72E-001 0.00E+000 0.00E+000
    1.36E+001 1.31E+000 7.64E-001 2.34E-001 0.00E+000 0.00E+000
    1.41E+001 1.32E+000 7.57E-001 1.87E-001 0.00E+000 0.00E+000
```

```
A sample output file.
3
1               100
5               100
5               100
0.00E+000 1.04E-003 7.12E-004 5.22E-004 3.98E-004 3.10E-004
          1.04E-003 7.12E-004 5.22E-004 3.98E-004 3.10E-004
          1.03E-003 7.08E-004 5.19E-004 3.96E-004 3.09E-004
          1.03E-003 7.04E-004 5.15E-004 3.94E-004 3.08E-004
          1.02E-003 6.98E-004 5.10E-004 3.91E-004 3.06E-004
          1.01E-003 6.91E-004 5.03E-004 3.87E-004 3.03E-004
          9.92E-004 6.83E-004 4.95E-004 3.82E-004 3.00E-004
          9.81E-004 6.73E-004 4.86E-004 3.76E-004 2.96E-004
          9.68E-004 6.62E-004 4.75E-004 3.70E-004 2.92E-004
          9.53E-004 6.50E-004 4.64E-004 3.62E-004 2.87E-004
          9.37E-004 6.36E-004 4.51E-004 3.54E-004 2.82E-004
          9.19E-004 6.21E-004 4.37E-004 3.46E-004 2.77E-004
          9.00E-004 6.05E-004 4.23E-004 3.37E-004 2.71E-004
          8.79E-004 5.87E-004 4.07E-004 3.27E-004 2.64E-004
          8.56E-004 5.68E-004 3.92E-004 3.17E-004 2.57E-004
          8.32E-004 5.48E-004 3.75E-004 3.07E-004 2.50E-004
          8.06E-004 5.26E-004 3.58E-004 2.96E-004 2.43E-004
          7.78E-004 5.03E-004 3.41E-004 2.85E-004 2.36E-004
          7.49E-004 4.79E-004 3.24E-004 2.74E-004 2.28E-004
          7.18E-004 4.54E-004 3.07E-004 2.62E-004 2.20E-004
          6.86E-004 4.28E-004 2.90E-004 2.50E-004 2.12E-004
          6.53E-004 4.02E-004 2.73E-004 2.39E-004 2.04E-004
          6.19E-004 3.75E-004 2.56E-004 2.27E-004 1.96E-004
          5.84E-004 3.48E-004 2.40E-004 2.16E-004 1.87E-004
          5.49E-004 3.21E-004 2.24E-004 2.04E-004 1.79E-004
          5.13E-004 2.94E-004 2.08E-004 1.93E-004 1.71E-004
          4.77E-004 2.67E-004 1.93E-004 1.82E-004 1.63E-004
          4.41E-004 2.41E-004 1.79E-004 1.71E-004 1.55E-004
          4.05E-004 2.15E-004 1.65E-004 1.61E-004 1.47E-004
          3.70E-004 1.91E-004 1.52E-004 1.50E-004 1.39E-004
          3.36E-004 1.68E-004 1.39E-004 1.40E-004 1.31E-004 ...
```

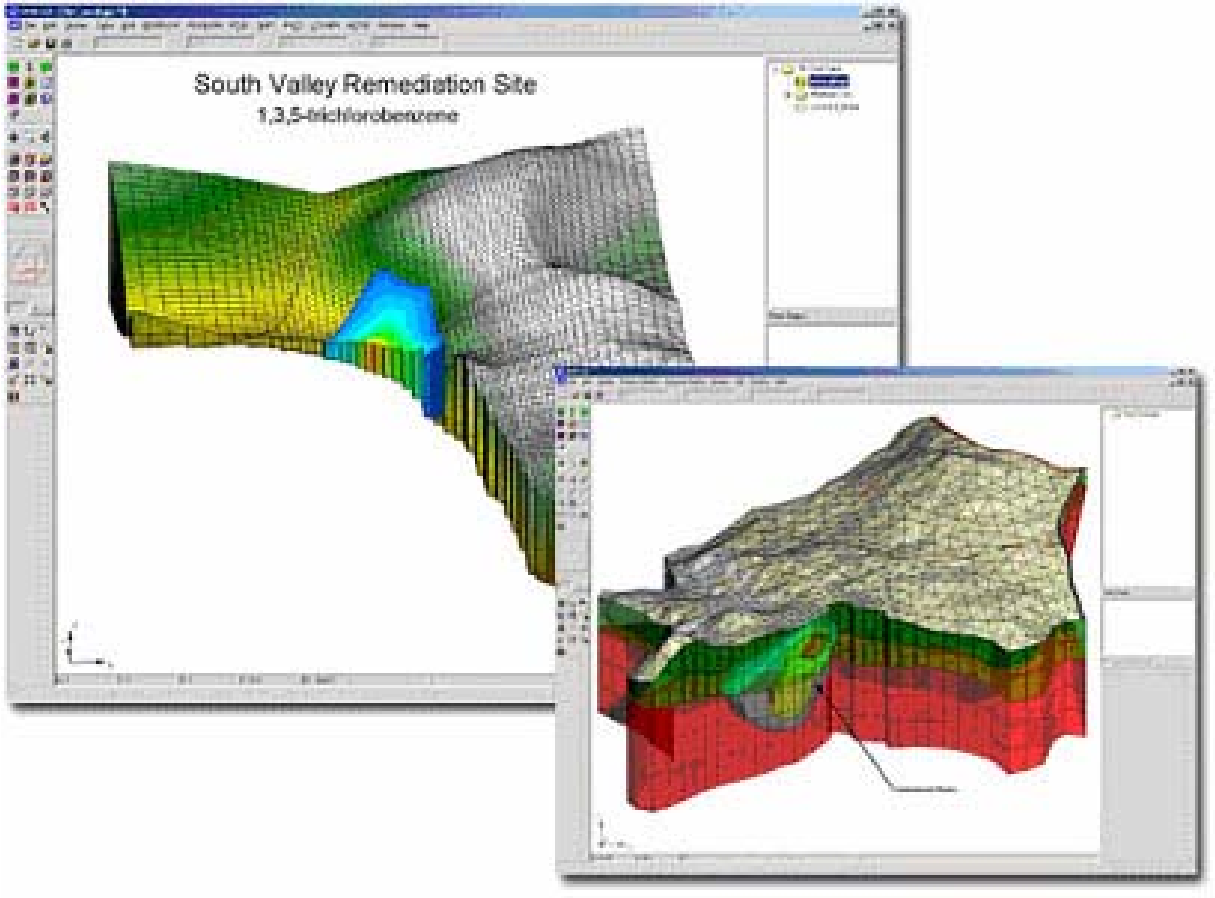
Transparency in the User Interface

Better UI design: Graphical forms and output



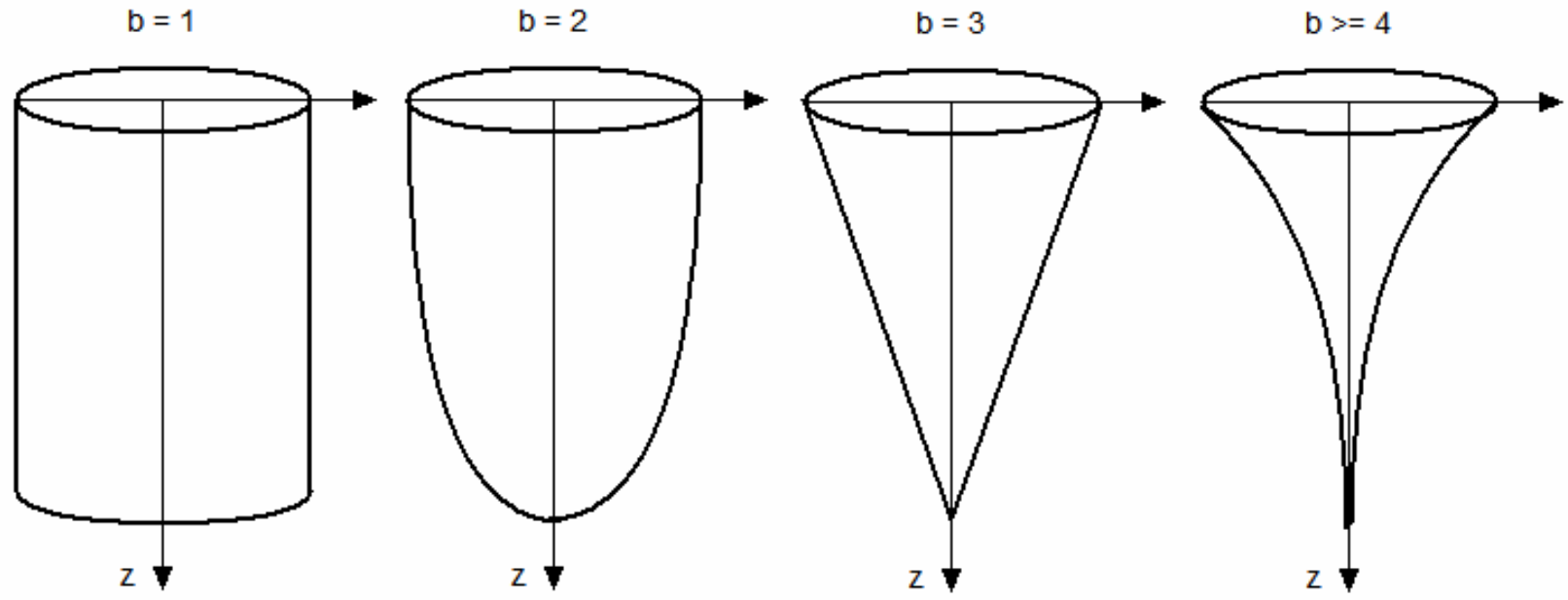
Transparency in the User Interface

Even better UI design: Interactive tools



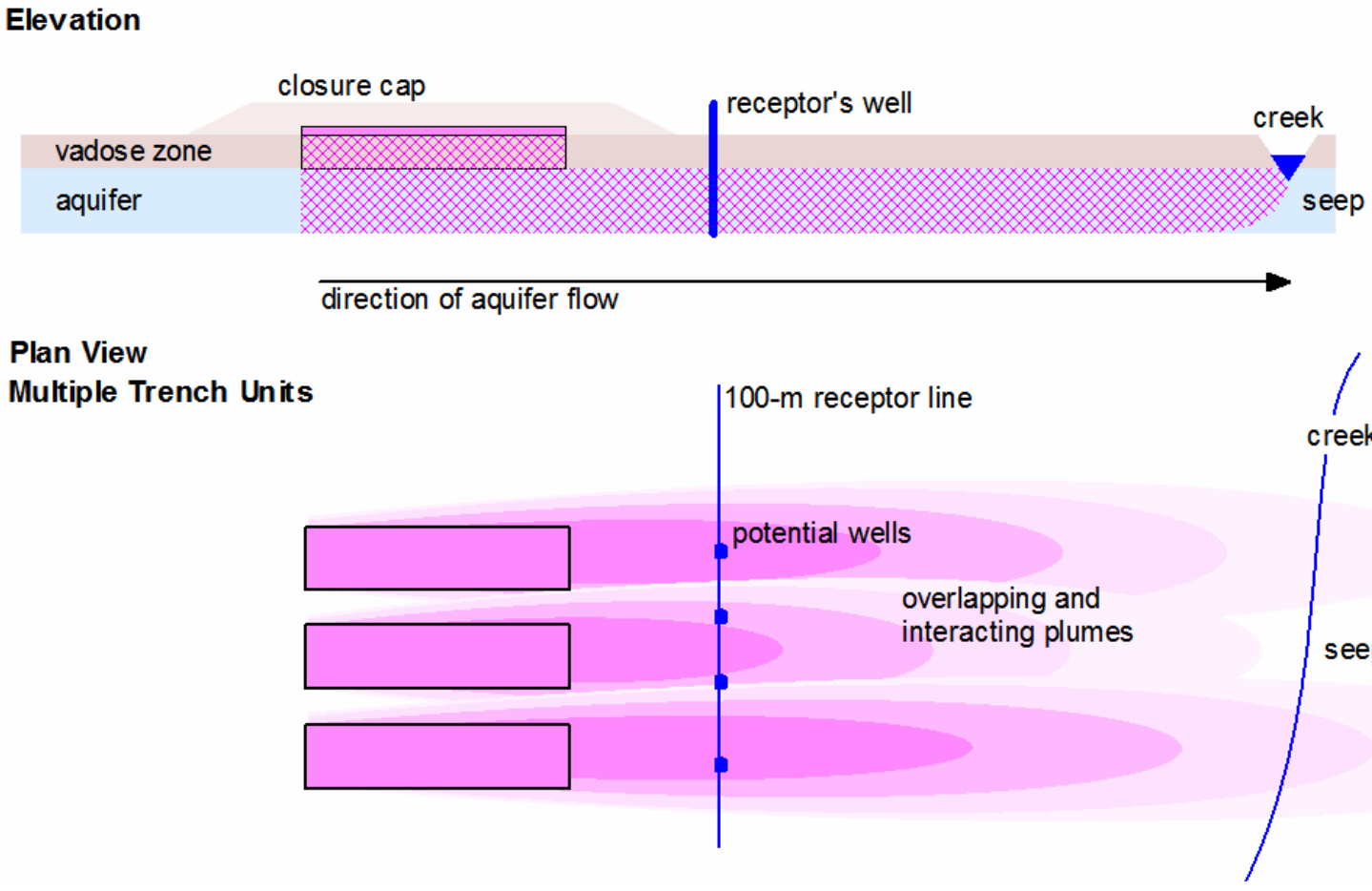
Transparency in Concepts

The shape of root masses (or burrows) underground is shown here for various values of b:



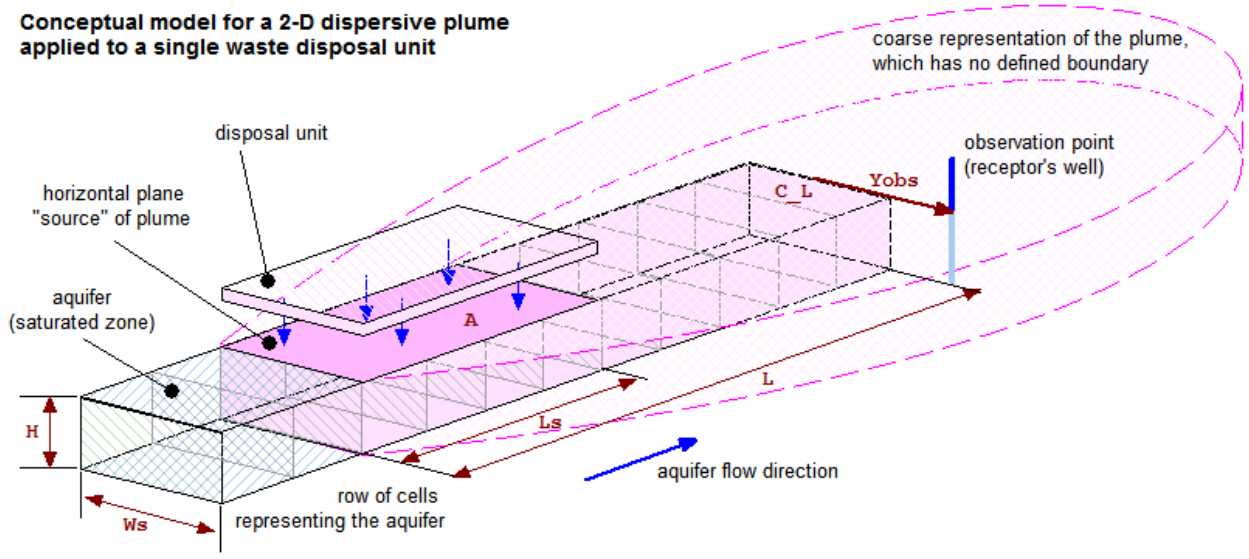
A simple illustration can aid explanation

Transparency in Concepts



Transparency in Concepts

Modeling tools can be described



Application of the GoldSim Plume Function

As described in the GoldSim on-line help (search for "plume"), the plume() function accepts 11 arguments. The description presented here is somewhat simplified for the case at hand. The arguments to the function are as follows, with comments following the "//". Footnotes are below.

```
plume (
      L,          // length of the Pipe or row of Cells, as measured from
                  //    the upstream end of the Source[1]
      A,          // cross-sectional area of the Pipe or Cells
      Ls,         // length of the Source set equal to the length of the
                  //    overlying disposal unit, parallel to flow
      0,          // vertical offset of observation point (zero)[2]
```

Transparency in Concepts

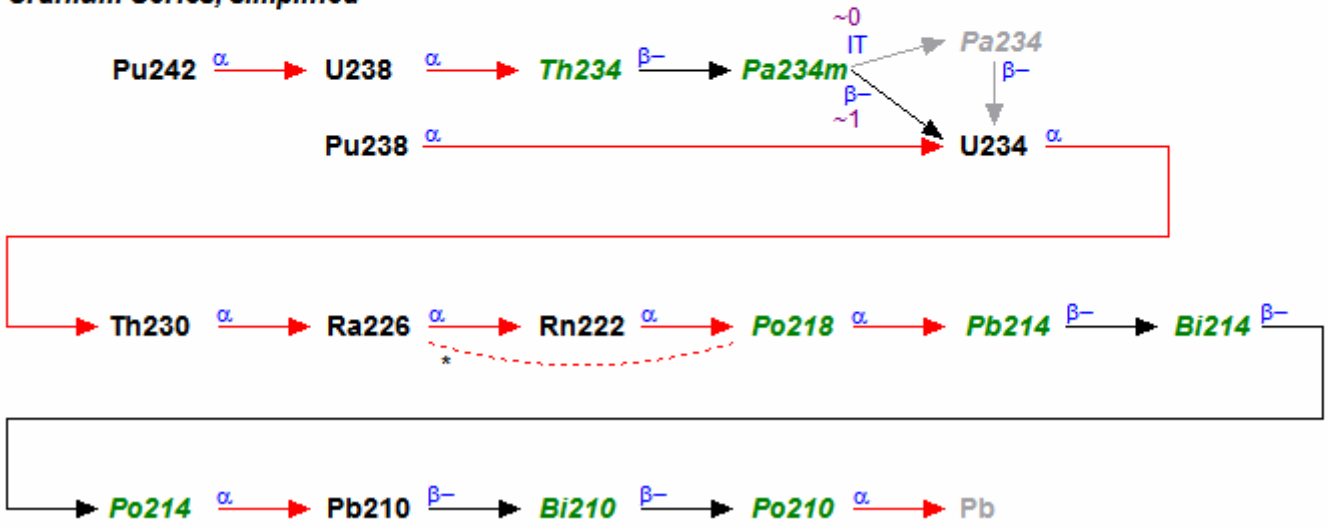
Decay chains implemented in contaminant transport and dose calculations

Note that the radionuclides and stable nuclides in black are maintained in the Species list. Any modification to the decay chain diagram needs to have an associated modification to the Species list, and vice versa.

The radionuclides noted in green italic are considered in the dose assessment only, through dose coversion factors. Environmental transport of these progeny is assumed to follow their respective parents, with which they are in secular equilibrium.

Radionuclides, stable nuclides, and decay arrows in gray are not represented in the model, but are shown here for completeness.

Uranium Series, simplified



** Rn222 is partially bypassed in proportion to account for partial emanation.*

Transparency in Documentation

Models should be ...

- readable,
- traceable,
- supported, and
- *informative*.

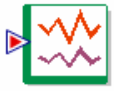
Readability

Project budget and accounting

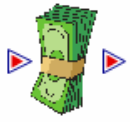
The user can specify the funding profile, which constitutes annual increases to the project account. Costs are deducted from the project account as tasks start and complete.

Main Project Account

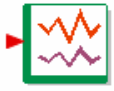
ProjectFundingProfile



ProjectFundingHistory



ProjectAccount



ProjectAccountHistory

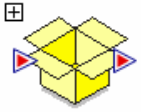
The ProjectAccount has revenues added each FY, as worked out above.

It also has these deductions:
- each task deducts its estimated cost on task start
- each task reconciles its actual costs with the estimated cost, and deducts the difference on completion of the task
- penalties and fines are deducted as they occur

Funding Profile (set on Control Panel)

Control Panel

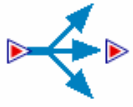
Estimated expenses and allocation priorities



EstimatedCosts

Estimated costs for each task are provided here. Each task must wait until sufficient funding is available before starting, and actual costs are reconciled with estimates on task completion.

Funding allocations are determined as annual spending rates.



Project_Alloc

The allocation of funds from the top Project level down to the individual tasks takes place hierarchically. This top level allocator takes the entire project budget (ProjectAccount) and allocates to the main activities. Each of those activities similarly allocates its share of the funds it was provided to its tasks, and so on.

Waste Characterization Funding

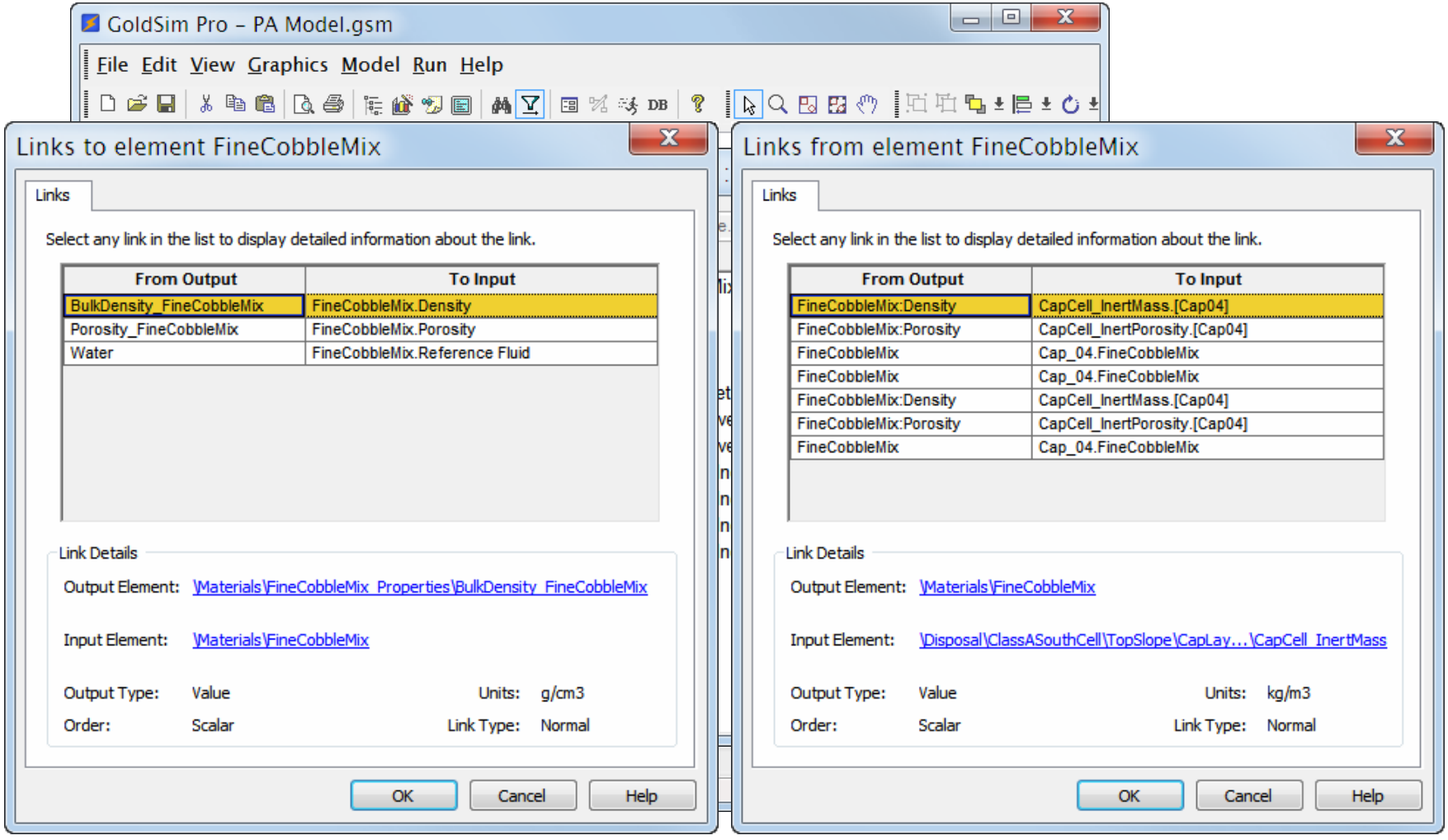
Public Involvement Funding

Operations Funding

Compliance Activities Funding

Public Involvement Activities Funding

Traceability Within the Model



Traceability Outside the Model

TABLE 7. HELP INFILTRATION MODEL LAYERS AND MATERIAL PROPERTIES

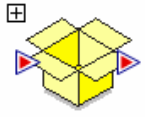
Layer	Material	Thickness (inches)	n (vol/vol)	θ_{fc} (vol/vol)	θ_{wp} (vol/vol)	Available Moisture (vol/vol)	θ_i (vol/vol)	K_s (cm/sec)	Layer Type n/a	Size Range (inches)	Material Description n/a	Notes
Layer 1	Type-B Rip Rap	18	0.190	0.024	0.007	0.017	initialized to ss	42	vertical percolation	0.75-4.5	1.25 inches	Size is nominal diameter
Layer 2	Type-A Filter (upper)	6	0.190	0.024	0.007	0.017	initialized to ss	42	vertical percolation	*0.08-6.0*	Coarse *Sand - Fine* Cobble	
Layer 3	Sacrificial Soil	12	0.31	0.2	0.025	0.175	initialized to ss	4.00E-03	vertical percolation	<0.75	Silty Sand and Gravel	Placed at $4x10^{-4}$ cm/sec; freeze/thaw reduces K to $4x10^{-3}$ cm/sec.
Layer 4	Type-B Filter (lower)	6	0.28	0.032	0.013	0.019	initialized to ss	3.5	lateral drainage	0.2-1.5	Coarse Sand -Fine Gravel	
Layer 5	Upper Radon Barrier	12	0.430	0.390	0.28	0.11	0.43	5.00E-08	barrier soil	n/a	Clay	
Layer 6	*Lower Radon* Barrier	72	0.430	0.390	*0.28*	*0.11*	0.39	1.00E-06	vertical percolation	n/a	Clay	
Layer 7	Waste	100	0.437	0.062	0.024	0.038	initialized to ss	5.00E-04	vertical percolation	n/a	Sand	Unit thickness for waste. Model is insensitive to waste thickness variation.
Layer 8	Clay Liner	24	0.430	0.390	0.28	0.11	0.43	1.00E-06	barrier soil	n/a	Clay	

n = Porosity
θfc = Field Capacity
θwp = Wilting Point
θi = Initial Moisture Content
K_s = Saturated Hydraulic Conductivity
θ_i = Value for initialized steady-state moisture content are given in the model output files.
Available Moisture: = Moisture available to be evaporated is only applicable in the upper 18 inches of the model

Engineered material properties

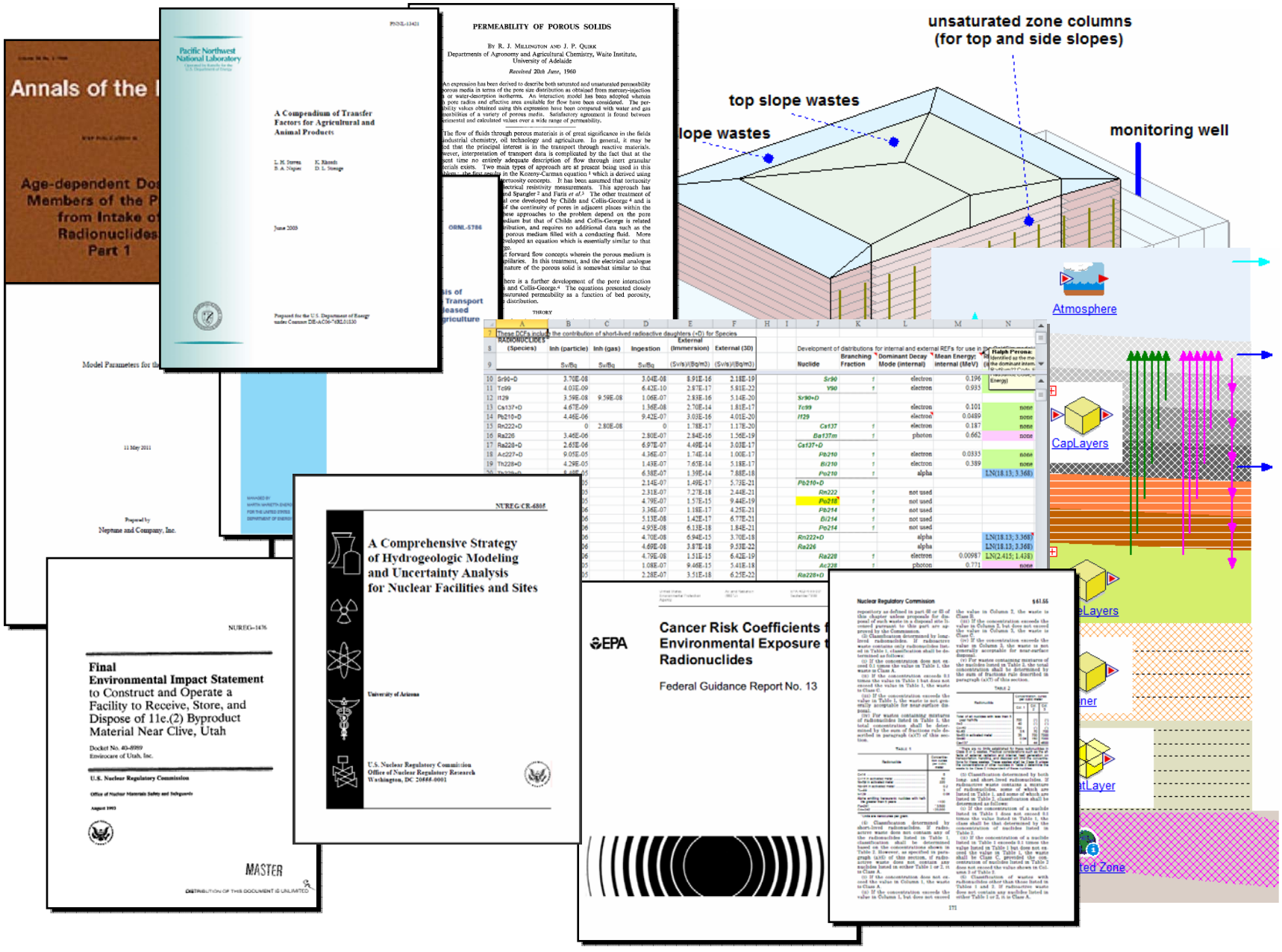
Engineered materials are in a variety of forms serving various purposes. These are used in the construction of the cap (top slope and side slope) and liner layers.

RipRap



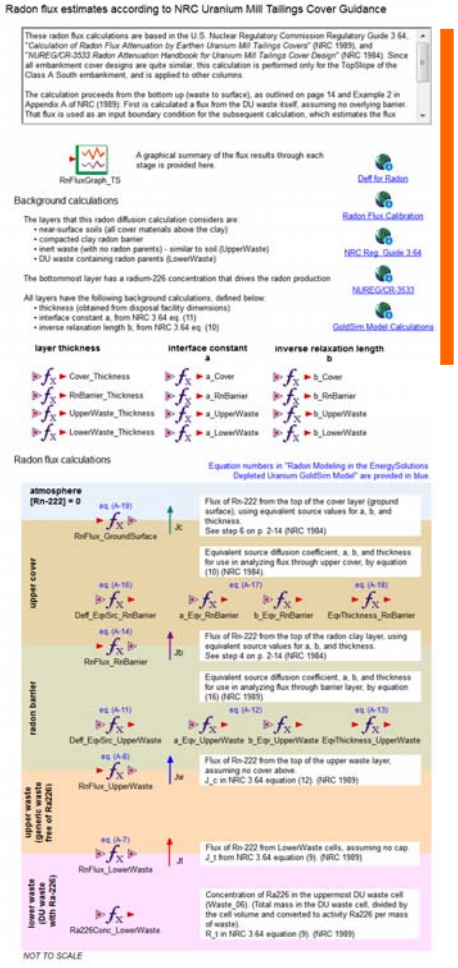
RipRap_Properties

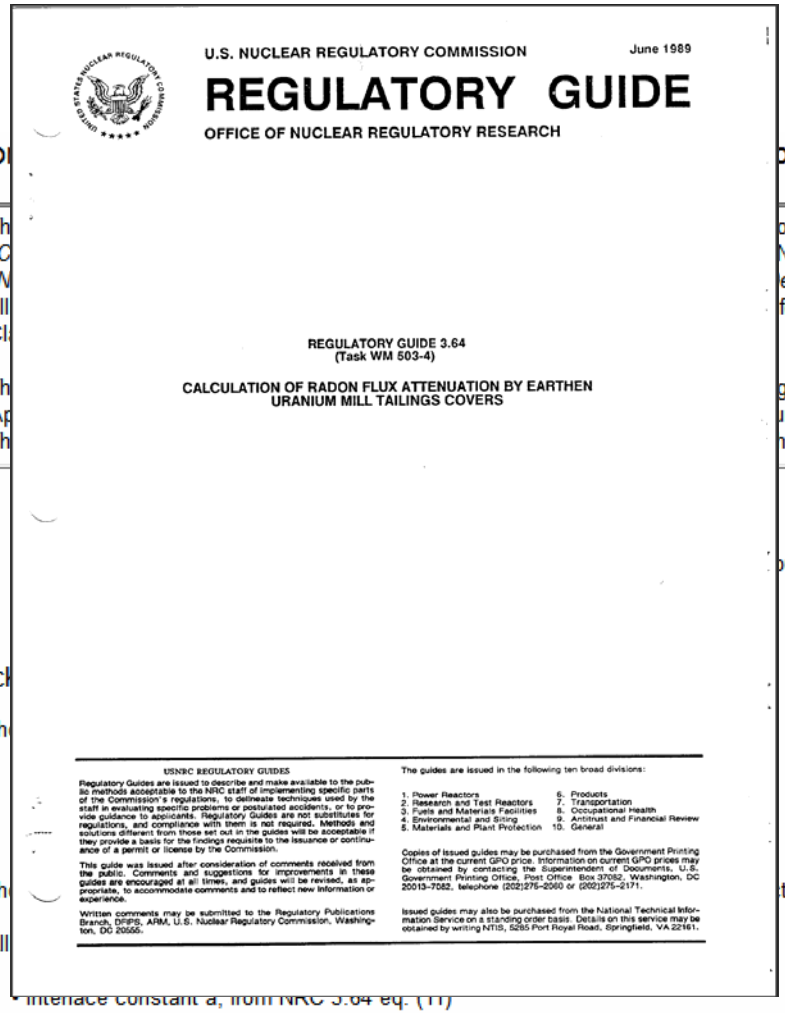
Rip Rap is used to construct the uppermost layer: Armor. It quickly becomes infilled with Loess. The Rip Rap itself is assumed to be an inert material.


unsaturated zone columns
(for top and side slopes)
top slope wastes
lope wastes
monitoring well
Atmosphere
CapLayers
Annals of the I
Age-dependent Dos
Members of the P
from Intake of
Radionuclides
Part 1
Pacific Northwest National Laboratory
A Compendium of Transfer Factors for Agricultural and Animal Products
PERMEABILITY OF POROUS SOLIDS
By R. J. Millington and J. P. Quirk
Departments of Agronomy and Agricultural Chemistry, Waite Institute, University of Adelaide
Received 20th June, 1960
ORNL-5786
Model Parameters for th
Prepared by
Neptune and Company, Inc.
NUREG-1476
Final
Environmental Impact Statement
to Construct and Operate a
Facility to Receive, Store, and
Dispose of 11e.(2) Byproduct
Material Near Clive, Utah
Docket No. 40-8989
Envirocare of Utah, Inc.
U.S. Nuclear Regulatory Commission
August 1993
MASTER
NUREG/CR-6805
A Comprehensive Strategy
of Hydrogeologic Modeling
and Uncertainty Analysis
for Nuclear Facilities and Sites
University of Arizona
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001
EPA
Cancer Risk Coefficients f
Environmental Exposure t
Radionuclides
Federal Guidance Report No. 13
Nuclear Regulatory Commission
RADIONUCLIDES (Species)
Inh (particle)
Inh (gas)
Ingestion
External (Immersion)
External (3D)
Nuclide
Branching Fraction
Dominant Decay Mode (internal)
Mean Energy: internal (MeV)
Sr90+D
Tc99
I129
Cs137+D
Pb210+D
Rn222+D
Ra226
Ra228+D
Ac227+D
Th228+D
Pb210
Bi210
Po210
Rn222
Po218
Pb214
Bi214
Po214
Ra228
Ac228
electron
photon
alpha
not used
none
LN(18.13; 3.368)
LN(2.415; 1.428)

Print Close

Bringing it Together




U.S. NUCLEAR REGULATORY COMMISSION
June 1989
REGULATORY GUIDE
OFFICE OF NUCLEAR REGULATORY RESEARCH
REGULATORY GUIDE 3.64
(Task WM 503-4)
CALCULATION OF RADON FLUX ATTENUATION BY EARTHEN URANIUM MILL TAILINGS COVERS
USNRC REGULATORY GUIDES
Regulatory Guides are issued to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.
This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience.
Written comments may be submitted to the Regulatory Publications Branch, DFIPS, ARM, U.S. Nuclear Regulatory Commission, Washington, DC 20555.
The guides are issued in the following ten broad divisions:
1. Power Reactors
2. Research and Test Reactors
3. Fuels and Materials Facilities
4. Environmental and Siting
5. Materials and Plant Protection
6. Products
7. Transportation
8. Occupational Health
9. Antitrust and Financial Review
10. General
Copies of issued guides may be purchased from the Government Printing Office at the current GPO price. Information on current GPO prices may be obtained by contacting the Superintendent of Documents, U.S. Government Printing Office, Post Office Box 37082, Washington, DC 20013-7082, telephone (202)275-2060 or (202)275-2171.
Issued guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161.

• inverse relaxation length b, from NRC 3.64 eq. (10)

Deff for Radon

Radon Flux Calibration

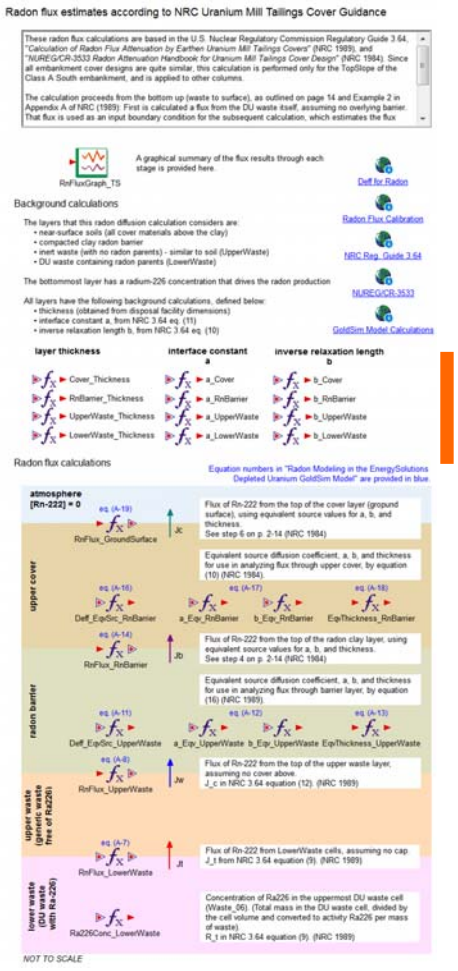
NRC Reg. Guide 3.64

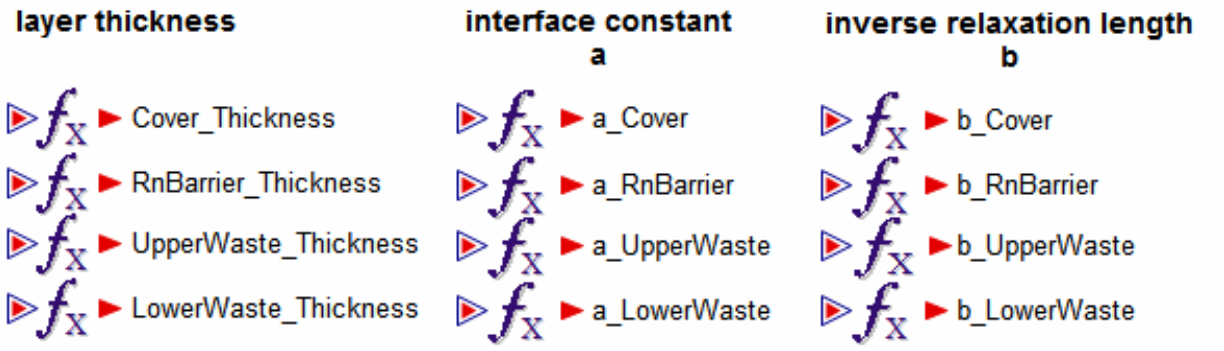
NUREG/CR-3533

GoldSim Model Calculations

Print Close

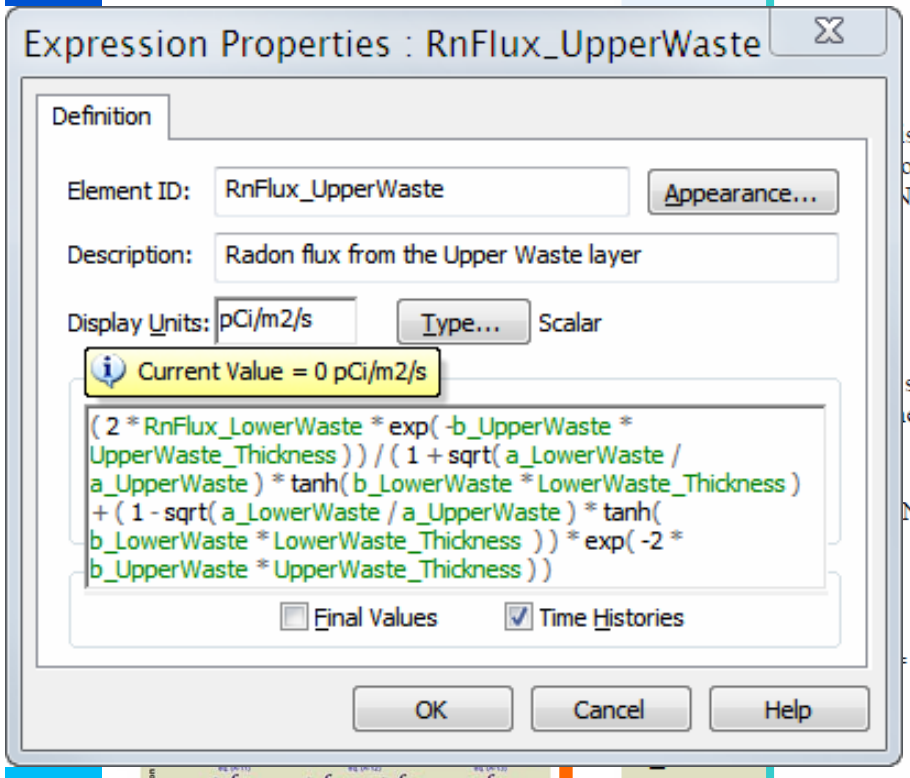
Bringing it Together





Sometimes simply organizing the appearance of calculations can help in communicating their role.

Bringing it Together



This flux is given by NRC (eq. 3 in NRC, 1984 and eq. 9 in NRC, 1989) as

$$J_t = R_t \rho_t E_t \sqrt{\lambda D_t} \tanh\left(x_t \sqrt{\lambda / D_t}\right) \qquad \text{(A-7)}$$

s used in the second step to solve for the surface flux of radon assuming continuity of ontinuity of concentration across the tailings-cover interface (eq. 4 in NRC, 1984 and RC, 1989):

$$J_c = \frac{2 J_t \exp(-b_c x_c)}{1 + \sqrt{\frac{a_t}{a_c}} \tanh(b_t x_t) + \left[1 - \sqrt{\frac{a_t}{a_c}} \tanh(b_t x_t)\right] \exp(-2 b_c x_c)} \qquad \text{(A-8)}$$

subscript *c* refers to the cover (in this case, the bottommost layer of inert Class A e inverse relaxation lengths are defined as

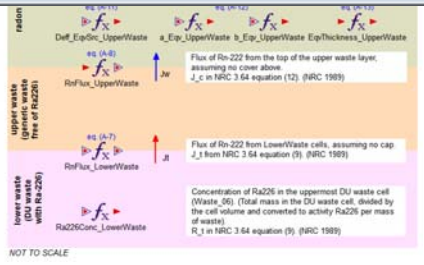
$$b_t = \sqrt{\lambda / D_t} \quad \text{and} \quad b_c = \sqrt{\lambda / D_c} \qquad \text{(A-9)}$$

NRC, 1989) and the interface constants are defined (eq. 11 in NRC, 1989) as

$$a_t = n_t^2 D_t \left[1 - (1-k) m_t\right]^2 \quad \text{and} \quad a_c = n_c^2 D_c \left[1 - (1-k) m_c\right]^2 \qquad \text{(A-10)}$$

equilibrium distribution coefficient for radon in water and air (pCi cm^{-3} water per pCi cm^{-3} air).

Radon Modeling 15



waste
c waste
Ra226)

$$J_c = \frac{2J_t \exp(-b_c x_c)}{1 + \sqrt{a_t/a_c}\tanh(b_t x_t) + [1 - \sqrt{a_t/a_c}\tanh(b_t x_t)]\exp(-2b_c x_c)} \qquad (12)$$

Transparency in Decision Making

Decision makers include ...

- regulators
- site operators

Decision makers must ...

- answer to science,
- answer to the law,
- answer to the public,
- live with uncertainty, and
- sleep at night.

Performance Assessment should help in all these aspects.

Science

$$N_i = \lambda_1 \lambda_2 \cdots \lambda_{i-1} N_{1(0)} \sum_{j=1}^{i} \frac{e^{-\lambda_j t}}{\prod_{k \neq j} (\lambda_k - \lambda_j)}$$

$$C_{water} = \left(1 + K_d \frac{\rho_b}{\theta_w}\right) \times C_{soil}$$

$$v_x = \frac{K}{n} \nabla h$$

$$Q_{atm} = f_R \times C_{soil}$$

$$\tilde{J} = -\theta_w D_s \nabla C$$

Public

Law and Regulation

§ 61.41 Protection of the general population from releases of radioactivity.

Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

§ 61.42 Protection of individuals from inadvertent intrusion.

Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

P. Disposal. Low-level waste disposal facilities shall meet the following requirements.

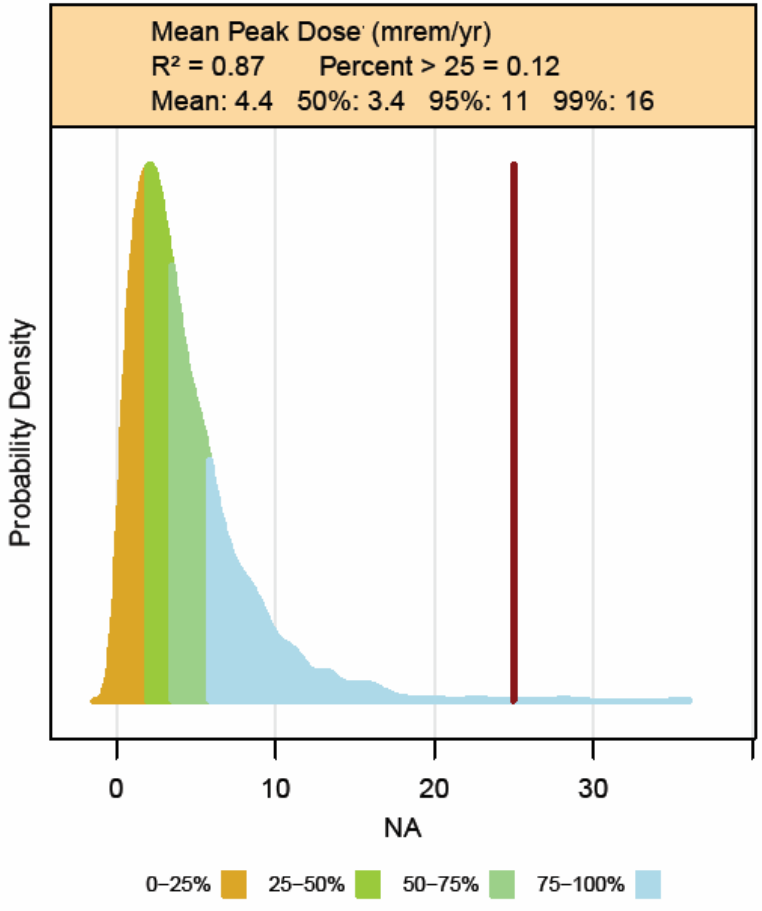
(1) **Performance Objectives**. Low-level waste disposal facilities shall be sited, designed, operated, maintained, and closed so that a reasonable expectation exists that the following performance objectives will be met for waste disposed of after September 26, 1988:

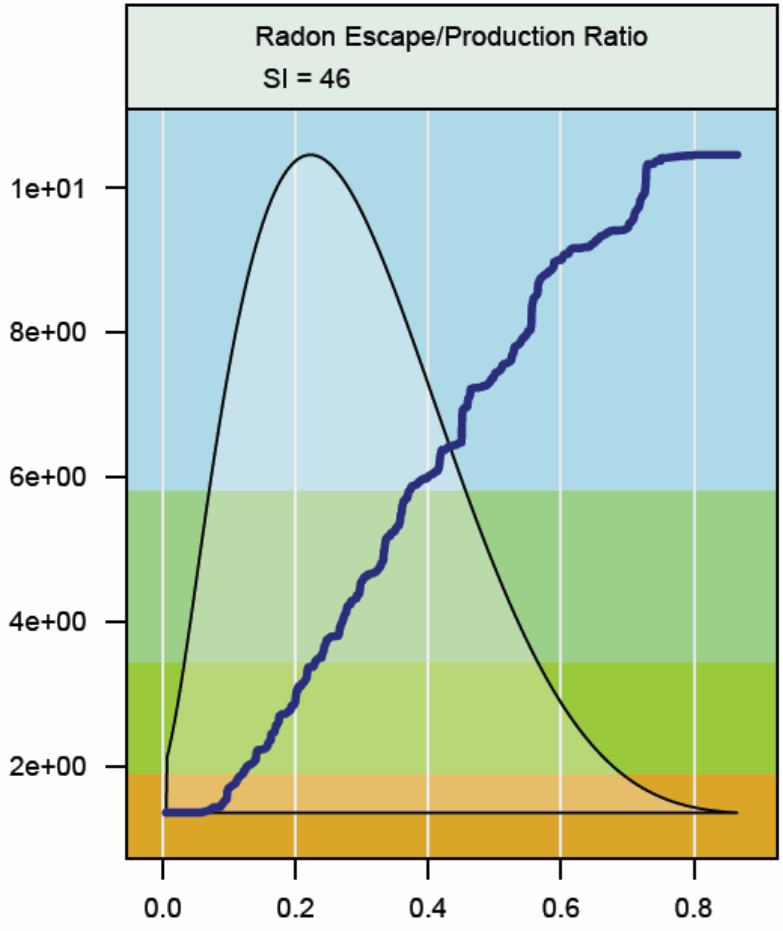
(a) Dose to representative members of the public shall not exceed 25 mrem (0.25 mSv) in a year total effective dose equivalent from all exposure pathways, excluding the dose from radon and its progeny in air.

(b) Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year total effective dose equivalent, excluding the dose from radon and its progeny.

(c) Release of radon shall be less than an average flux of 20 $pCi/m^2/s$ (0.74 $Bq/m^2/s$) at the surface of the disposal facility.

Uncertainty





Conscience


THE GOVERNMENT IS NAGGING US TO GET RID OF OUR DANGEROUS RADIOACTIVE WASTE.
ON A TOTALLY DIFFERENT TOPIC, I'M GIVING EACH OF YOU A MOTIVATIONAL PAPERWEIGHT THAT SAYS, "NICE GOING."
TRY TO AVOID LICKING THEM.
Dilbert.com DilbertCartoonist@gmail.com
© 2011 Scott Adams, Inc./Dist. by UFS, Inc.
3-1-11

Print Close