# SCIENTIFIC NOTEBOOK

# 170-21E

# SCIENTIFIC NOTEBOOK 170E
# Chapter 21

by

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# INITIAL ENTRIES

Scientific Notebook: #170E Chapter 21

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Title: Documentation of analyses made in support of TPA code 5.0

Initial Entry:
The purpose of this Chapter 21 of Scientific notebook 170E is to document the analyses of hydrological processes I made in support of TPA code version 5.0 development. I started this chapter to document the development of a revised TPA code *strmtube.dat* file, which is used to define the saturated zone flow and transport system for the code. The chapter may be used for analyses subsequent to that, but so far that is all I have planned.

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**5/16/2003 – here is the documentation of my analysis for Development of SZ Streamtubes for updated TPA code version 5.0 base case**

***Important Note:*** To develop and verify this abstraction, I am using the preliminary TPA5.0d code, as suggested by Ron Janetzke. I obtained this code and input files from the CNWRA network UNIX directory /solapps/cnwra/A_tpa5.0d. All stream tubes are based on the EDAII repository design geometry that was specified in the tpa.inp file of that directory.

Process Modeling using MODFLOW and MODPATH were used to develop the geometries of the streamtubes as discussed on the following pages. These process models are archived with CNWRA scientific notebook 480E. In that notebook, refer to *run4* of model grid S6a for the MODFLOW results, and the three separate *tpa5-streamtube* runs for the MODPATH results.

**Summary of changes to strmtube.dat file for TPA 5.0 base case**

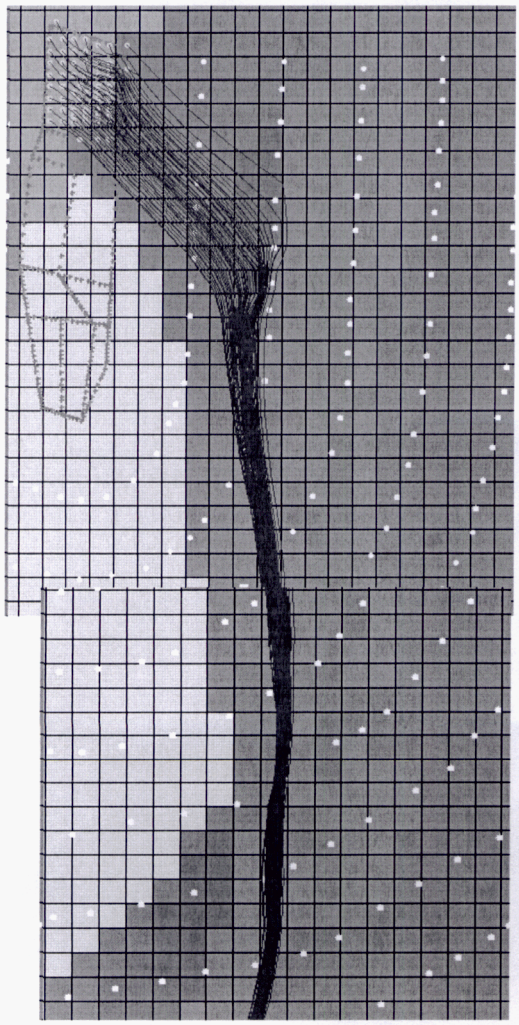
1. Change line with distances to receptor group 10. , 18. (it was 10., 20 in tpa4.0)

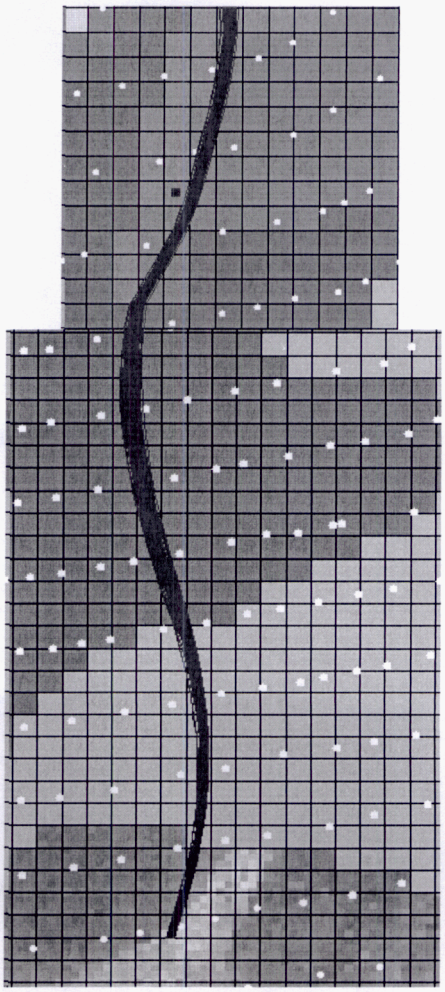
2. Revise flow centerlines under repository area so that they pick up the desired subareas as described below in the notes.

3. Revised the streamtube segment geometries for the three streamtubes based on the process model results, as described in following notes.

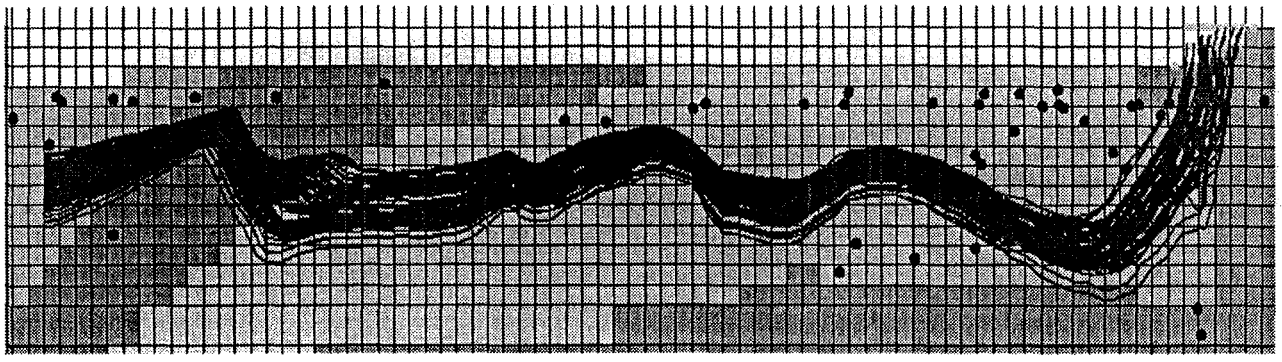
4. I deleted a bunch of comment notation from the old strmtube.dat file that didn't really make much sense and was not necessary to be in an input file. I added in a few minor comments.

**Northernmost Streamtube:** originating from EDAII subareas 9 and 10
The views below are the ones I used to estimate the streamtube widths and centerline arclengths for the northern streamtube of the streamtube.dat file. I printed them up larger and used a ruler on paper to measure the widths and lengths. I did not retain the original scrap paper, but you should be able to check my measurements roughly against these figures if so inclined. White dots on the images define constant distance circles around the EDAII repository design.





The view at bottom is a N-S vertical view of the entire set of flow paths from subareas 9 and 10 to the 18 km compliance boundary. Grids are 300 m horizontal and 50 m vertical along flow paths. To get the arclengths for streamtube segments, pretty much just printed out some close up working views of these stream paths and measured with a ruler. Model files for these particle paths are archived with CNWRA scientific notebook 480E. In general, the vertical flow direction doesn't add much to the path length; it looks like it does here, but that is because of the 7:1 vertical exaggeration in the figure



This table summarizes the interpreted streamtube geometry for the above figures.

**Northern streamtube segment geometry**

| Distance from repository (km) | Width of segment (m) | Centerline arc length (m) | Notes from process Model: |
|---|---|---|---|
| 1.5 | 1200 | 2200 | flow descends about 200-500 m |
| 2 | 500 | 2400 | fairly level flow in FMC/PBC fault zone |
| 3 | 300 | 1500 | |
| 7 | 225 | 4500 | |
| 10 | 175 | 3300 | flow in LVA |
| 13 | 250 | 3000 | |
| 13.5 | 225 | 500 | flow ascends ~100 thru UVC layer into UVA; may be porous flow in UVC layer. |
| 15 | 175 | 1500 | Flow in UVA, ascends ~200 m |
| 18 | 150 | 3000 | Flow in alluvium |

Arclengths based on two-dimensional measurements of 3-D paths, but a quick calculation showed

that adding in the vertical flow component would add less than 2% to the arc lengths, even where vertical flow was most pronounced.

Basically, I followed the same procedure for the other two streamtubes, and do not repeat all the figures for those tubes in these notes. The middle streamtube is designed to handle subareas 1, 2, 4, and 8, which is different than in TPA 4 where it only handled 1, 2, and 8. Tables for the segment geometries of the other two tubes follow:

**Central Streamtube -- segment geometry**

| Distance from repository (km) | Width of segment (m) | Centerline arc length (m) | Notes from process Model: |
|---|---|---|---|
| 1 | 1450 | 1350 | flow descends ~250-450 m into LVA |
| 3 | 450 | 3000 | Fairly level moving into FMW/PBC zone |
| 9.5 | 250 | 6500 | Fairly level flow in FMW/PBC zone |
| 13 | 400 | 3500 | flow in LVA |
| 13.5 | 375 | 500 | flow ascends ~100 thru UVC layer into UVA; may be porous flow in UVC layer. |
| 15 | 325 | 1500 | Flow in UVA, ascends ~200 m |
| 18 | 225 | 3000 | Flow in alluvium |

**Southern Streamtube -- segment geometry**

| Distance from repository (km) | Width of segment (m) | Centerline arc length (m) | Notes from process Model: |
|---|---|---|---|
| 1.5 | 1500 | 1500 | flow descends ~150-250 m into LVA |
| 2.5 | 450 | 1000 | Fairly level moving into FMW/PBC zone |
| 4 | 300 | 1500 | Fairly level flow in FMW/PBC zone |
| 6.5 | 225 | 2500 | |
| 9 | 350 | 2500 | |
| 12.5 | 550 | 3500 | flow in LVA |
| 13 | 450 | 500 | flow passes through UVC layer into UVA; may be porous flow in UVC layer. |

| | | | |
|---|---|---|---|
| 15 | 375 | 2000 | Flow in UVA, ascends ~200 m |
| 18 | 220 | 3000 | Flow in alluvium |

**Flux Rates for Strmtube.dat file:**
To be consistent with the 3D process model results the flux rates for each streamtube should result in GWTT estimates to the 18km boundary that are consistent with the ranges of travel times calculated using MODPATH for particles originating from the three stream tube source areas. I got ballpark estimates of what the flux through streamtubes should be from the process model, but the model grid cells are not matched to the geometry of the particle paths, so I can only really get an estimate that way. I figured from looking at cell flow rates that fluxes should be on the order of about 100 m^3/yr/m (in the units of TPA space), so I started with that and adjusted the values for each streamtube to match the average of the individual subarea travel times to the average particle travel times from the MODPATH simulations used to define each stream tube.

**Following table is a summary of groundwater travel times for the particles released in the three streamtubes obtained from the MODPATH simulations that defined the tubes, compared to the results of using the indicated fluxes in TPA 5.0**

| **Stream tube** | **TPA 5.0 Strmtube.dat input flux** | **MODPATH travel time to 18-km boundary** | **TPA 5.0 SZ travel time results from gwttuzsz.rez file** |
|---|---|---|---|
| 1. Southern Tube:<br><br>Receives from subareas 3, 5, 6, 7 | **108** [$m^3$/yr/m] | 63 particles released<br>min. travel time = 270 yr<br>max. travel time = 290 yr<br>avg travel time = 280 yr | Subarea 3: 283 yr<br>Subarea 5: 282 yr<br>Subarea 6: 280 yr<br>Subarea 7: 279 yr |
| 2. Central Tube<br><br>Receives from subareas 1, 2, 4, 8 | **103** [$m^3$/yr/m] | 60 particles released<br>min. travel time = 269 yr<br>max. travel time = 328 yr<br>avg travel time = 297 yr | Subarea 1: 302 yr<br>Subarea 2: 296 yr<br>Subarea 4: 297 yr<br>Subarea 8: 302 yr |
| 3. Northern Tube<br><br>Receives from subareas 9 and 10 | **66** [$m^3$/yr/m] | * 60 particles released<br>min. travel time = 306 yr<br>max. travel time = 376 yr<br>avg travel time = 338 yr | Subarea 9: 341 yr<br>Subarea 10: 336 yr |

TPA 5.0 results were obtained by fixing the following input parameters in tpa.inp:
AlluviumMatrixPorosity_SAV = 0.1
FractuePorosity_STFF = 0.001
StreamTubeWidthMultiplier[] = 1.0
SZFluxMultiplierAtGlacialMaximum[] = 1.0.
DistanceToTuffAlluviumInterface[km] = 15.0

These values are consistent with the porosity values assigned to the tuff and alluvium units in the MODPATH process model. The MODFLOW and MODPATH process models are archived with CNWRA scientific notebook 480E. In that notebook, refer to run4 of model grid S6a for the MODFLOW results, and the three separate tpa5-streamtube runs for the MODPATH results.

All other parameters for TPA runs were as originally found in /solapps/cnwra/A_tpa5.0d/tpa.inp

**Here is the Resulting Streamtube.dat file for TPA 5**

```
*********************************************************************
TITLE: TPA5 Stream Tube data for the saturated zone.
TITLE: Created by J.R. Winterle (jrw) 5/16/03
TITLE: Based on 3D saturated zone flow path simulation results
TITLE: Three streamtubes to 18-km distance from EDAII repository design
**
 3      Number of stream tubes.
**
** Flow Rates (m^3/yr/m)
**
 3
263.
252.
155.
**
** Distance to Receptor Well
**  set 2 values: should match "DistanceToReceptorGroup..." in tpa.inp and the
**  well pumping and mixing zone data for DCAGW in tpa.inp ) (jrw 5/16/03)
**
10.0, 18.0
**
**
** Following inputs define center line coordinates for flow paths from beneath
the
** repository area to the entrance of the stream tubes, which begin on the
eastern edge of the
** repository footprint.  These points are used to determine which subareas
contribute to which
** streamtubes -- the line closest to the centroid of a particular subarea will
receive the mass
** for that subarea in its associated streamtube. (jrw 5/16/03)
**
**  Streamtube 1 is southernmost and should receive mass input
```

```
**  from EDAII subareas 3, 5, 6, and 7.
1
 3       Number of stream tube points for tube 1.
UTM-x[m]   UTM-y[m]
547400.,  4077550.
548000.,  4076750.
548400.,  4076600.
**
**  Streamtube 2 is central and should receive mass input
**  from EDAII subareas 1, 2, 4, and 8.
2
 3       Number of stream tube points for tube 2.
UTM-x[m]   UTM-y[m]
547550.,  4079400.
548000.,  4078800.
548475.,  4077500.
**
**  Streamtube 3 is northernmost and should receive mass input
**  from EDAII subareas 9 and 10.
3
 3       Number of stream tube points for tube 3.
UTM-x[m]   UTM-y[m]
547700.,  4081000.
548200.,  4080400.
548600.,  4080200.
**
**
**  DEFINITION OF STREAMTUBE SEGMENT GEOMETRIES
**
** I/F_Dist is linear distance from EDAII boundary
** width[m] is the average width of the streamtube since the last I/F_Dist
** tube_length[m] is the cumulative flow distance for all segments
**
** Southernmost streamtube
 10      Number of points for tube 1.
I/F_Dist   width[m]  tube_length[m]
0.0   1400.,      0.
1.5   1500.,      1500.
2.5   450., 2500.
4.0   300., 4000.
6.5   225., 6500.
9.0   350., 9000.
12.5  550., 12500.
13    450., 13000.
15    375., 15000.
18.0  220., 18000.
**
** Central streamtube
 8      Number of points for tube 2.
I/F_Dist   width[m]  tube_length[m]
0.0   1500.,      0.
1.0   1500.,      1350.
3.0   450., 4350.
9.5   250., 10850.
13.0  400., 14350.
13.5  375., 14850.
15.0  325., 16350.
```

```
18.0  225., 19350.
**
** Northernmost streamtube
 10      Number of points for tube 3.
I/F_Dist   width[m]  tube_length[m]
0.0   1300.,      0.
1.5   1200.,      2200.
2.0   500., 4600.
3.0   300., 6100.
7.0   225., 10600.
10.0  175., 13900.
13.0  250., 16900.
13.5  225., 17400.
15.0  175., 18900.
18.0  150., 21900.
**
endoffile
```

**********

**End of TPA 5 stream tube analysis.**

**Entries for June 16, 2003 - by J. Winterle**

I see a need to change some of the input parameters in the tpa.inp base case file for TPA-5. Below, I list the proposed revisions for these parameters, and the basis for the change.

++++++++++++++++++++++++++++++++
**uniform**
**DistanceToTuffAlluviumInterface[km]**
**12., 18.**

Basis: The mid-range value of 15 km is consistent with the modeling results obtained by Winterle (2003), which were based on an underlying hydrogeologic framework model by Sims et al. (1999). Lower bound value of 12 is based on location of Nye County well NC-EWDP-10S, which penetrates saturated alluvium at a distance of 12 km from the boundary of the EDA-II repository design. Upper bound of 18 km is based on a possible conceptual model in which a confining tuff-alluvium interface keeps flow paths within volcanic units beyond the 18-km compliance boundary.

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**constant**
**SZFluxMultiplierAtGlacialMaximum[]**
**1.0**

Basis: Modeling by Winterle (2003) suggests that groundwater fluxes and travel times in the saturated zone would not change significantly in the event of a regional water table rise and increased recharge. Additionally, the base case strmtube.dat file for TPA 5.0 is already based on a potential wetter future climate scenario.
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**uniform**
**StreamTubeWidthMultiplier[]**
**0.8, 1.2**

Basis: Evaluation of several alternative conceptual models (Winterle et al., 2002; Winterle, 2003) suggests that the widths of flow paths originating beneath the repository vary significantly only slightly between differing alternative model scenarios. Twenty percent above and below the mean value of 1.0 should bound this uncertainty.
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**References for above parameter changes**

Sims, D.W., J.A. Stamatakos, D.A. Ferrill, H.L. McKague, D.A. Farrell, A. Armstrong. *Three Dimensional Structural Model of the Amargosa Desert, Version 1.0*: Report to Accompany Model

Transfer to the Nuclear Regulatory Commission. CNWRA Letter Report. San Antonio, TX: Center for Nuclear Waste Regulatory Analyses. 1999.

Winterle, J.R. "Evaluation of Alternative Concepts for Saturated Zone Flow: Effects of Recharge and Water Table Rise on Flow Paths and Travel Times at Yucca Mountain." San Antonio, Texas: CNWRA. 2003.

Winterle, J.R., M.E. Hill, and C. Manepally. "Concepts of Saturated Zone Modeling for Development of a Site-Scale Groundwater Flow Model for Yucca Mountain." San Antonio, Texas: CNWRA. 2002.

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**J. Winterle** **SCIENTIFIC NOTEBOOK No. 170E Chapter 21**

Entries into Scientific Notebook #170E for pages __1__ - __12__ of Chapter 21 have been made by Jim Winterle.

No original text entered into this Scientific Notebook has been removed.

_____ March 23, 2005.

**Final Entry to close SNB170E, Chapter 21;**

I have reviewed this scientific notebook and find it in compliance with QAP-001. There is sufficient information regarding methods used for conducting tests, acquiring and analyzing data so that another qualified individual could repeat the activity.

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++++++++++++++++++++++++ no further entries ++++++++++++++++++++++++++++++