~~WPO 39495~~ 412367 ors 9/12/00

# Drilling Into A Salado Contaminated Plume Within the Controlled Area
**FEP Side Effort - S9**

# Drilling Into A Non-Salado Contaminated Plume Within the Controlled Area
**FEP Side Effort - NS6**

Kathleen Economy
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For Review
D. R. Anderson
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## Recommended Screening Decision

Drilling into a Salado contaminated plume within the controlled area is screened out on low consequences.
Drilling into a Non-Salado contaminated plume within the controlled area is screened out on low consequences.

## Screening Issue

A contaminant plume may form in the more transmissive units within the WIPP horizon. Exploratory drilling may provide connections between the repository and units above the repository which could potentially result in the development of a contaminated plume in these units. Those units of concern are Marker Beds 138, 139 and Marker Beds A and B of the Salado Formation, the Culebra and Magenta Dolomites within the Rustler Formation, and the Dewey Lake Redbeds of the Dewey Lake Formation. These plumes may be intersected by exploratory drilling, thereby bringing up contaminated cuttings to the accessible environment. The overall contribution of these cuttings to the Complimentary Cumulative Distribution Function (CCDF) must be evaluated.

## Basis for The Recommended Screening Decision

Requirements of 40 CFR 194 state the impact of drilling into a contaminated plume within the controlled area must be considered in a Performance Assessment as part of the Compliance Certification Application for WIPP. The rationale and basis for including such events as required by the rule are summarized in **FEP RI 3** - *Drilling into a Contaminated Plume Within the Controlled Area* (SWCF-A:1.2.07.3:QA:QA:TSK:RI3,RI4, RI6, RI7, RI8).

The probability of drilling into a contaminated plume is dependant on the drilling frequency per unit area. Drilling practices within the Delaware Basin have been investigated by the U.S. Department of Energy (DOE Draft Report, June 1996) in order to assess the frequency and likelihood of a drilling intrusion into and within the vicinity of the Waste Isolation Pilot Plant over a 10,000 year period after closure. Two borehole ‘ depths’ have been defined by EPA (EPA

1996) in order to determine the impact of a suite of boreholes on repository performance. Deep drilled boreholes are those that penetrate to and beyond the repository horizon of 655 m (2150 ft); shallow boreholes are those terminating at depths less than the repository depth. Drilling density rates for deep and shallow boreholes, as defined in the report, are given in Table 1. It should be noted, the total number of boreholes drilled through a shallow 'depth' is the sum of boreholes terminating at both shallow and deep depths but is not explicitly listed in Table 1.

**Table 1. Borehole Frequency to Be Considered by Performance Assessment**

| Types of Boreholes | Borehole per $Km^2$ |
|---|---|
| Shallow Borehole (terminating at depths less than 655 meters) | 21.821 |
| Deep Borehole (terminating at depths greater than 655 meters) | 46.766 |

Preliminary results of the Certification Compliance Application (CCA) set of calculations performed by the WIPP PA department indicate zones most likely to develop a plume are Marker Beds 138, 139 and Marker Beds A/B of the Salado Formation, the Culebra Dolomite of the Rustler Formation, and the Dewey Lake Redbeds of the Dewey Lake Formation. From this set of calculations a plume was seen to develop only in Marker Bed 139 and the Culebra Dolomite. No plume was seen in the Dewey Lake Redbeds, the Magenta Dolomite, or other Marker Beds within the Salado. The following is meant to demonstrate that, given the current PA model, it is not necessary to incorporate the contribution of contaminated cuttings from plumes formed in MB139 or the Culebra Dolomite to the CCA CCDF. The above recommendation is a result of exploring two screening approaches, probability and consequence, and are defined in the following sections.

## Drilling Into A Contaminated Plume developing within the Salado at Marker Bed 139 and the Culebra Dolomite.

A set of Performance Assessment (PA) CCA transport calculations were evaluated using the same flow and transport input parameters, model geometry and assumptions as that for the CCA calculations (see Analysis Plans for listed in Appendix A).

### Screening on Low Probability

The probability of intersecting both plumes is dependant on the plume size. The largest actinide releases are to the Culebra, therefore, borehole cuttings from a plume formed in this unit needs to be considered in order to determine the probability of releases. Maximum and minimum plume size ranges for the Culebra was determined using results of replicate 1 of the CCA PA calculations. Those vectors having the largest $^{239}$PU and $^{241}$Am Kds coupled with small block lengths (few fractures) exhibited small plumes, conversely, vectors having small Kds with large block lengths had larger plumes. Given this preliminary analysis it was determined plume sizes ranged between .000255 and .0624 kM$^2$ in the Culebra Dolomite. The probability of drilling into a contaminated plume is defined by:

$$P_{pl} = \frac{(\lambda \cdot \Delta t)^n}{n!} \cdot e^{-\lambda \Delta t} \qquad (1)$$

Where:

$P_{pl}$ = Probability of intersecting a plume

$\lambda$ = Drilling rate per plume (i.e., boreholes per kilometer$^2$ X's area of plume)

$\Delta$t = Time period to be considered

n = Number of Drilling Events, (i.e., boreholes per plume)

Table 2 lists the probabilities of drilling into a Culebra Dolomite and MB 139 contaminated plume conditioned on those minimum and maximum plume sizes expected in the Culebra over a 9900 year period (assuming 100 years of active institutional controls)..

**Table 2. Probability of Drilling into a 'Small' or 'Large' Culebra Plume and a Marker Bed Plume of Contanst Size (11.4 kM$^2$) Over a 9900 Year Period.**

| Number of Drilling Events | Probability of Drilling through a Small (.000255 kM$^2$) Plume | Probability of Drilling through a Large (.0625kM$^2$ ) Plume |
|---|---|---|
| 1 | 1.703e-02 | 6.076e-02 |
| 2 | **1.475e-04** | 1.290e-01 |
| 3 | 8.518e-07 | 1.827e-01 |
| 4 | 3.689e-09 | 1.939e-01 |
| 5 | 1.278e-11 | **1.647e-01** |
| 6 | 3.691e-14 | 1.166e-01 |
| 7 | 9.136e-17 | 7.075e-02 |
| 8 | 1.979e-19 | 3.756e-02 |
| 9 | 3.809e-22 | 1.772e-02 |
| 10 | 6.599e-25 | 7.528e-03 |
| 11 | 1.039e-27 | 2.906e-03 |
| 12 | 1.500e-30 | 1.029e-03 |
| 13 | 2.000e-33 | 3.361e-04 |
| 14 | 2.475e-36 | 1.020e-04 |
| 15 | 2.858e-39 | 2.887e-05 |
| 16 | 3.095e-42 | 7.662e-06 |
| 17 | 3.154e-45 | 1.914e-06 |
| 18 | 3.036e-48 | 4.517e-07 |
| 19 | 2.768e-51 | 1.010e-07 |
| 20 | 2.398e-54 | 2.144e-08 |

Using drilling rates of 68.59 boreholes per km per 10000 years and the above plume sizes the probabilities of intersecting a plume within the Culebra exceeded $10^{-4}$ . Therefore, cuttings from a borehole intersecting a contaminated plume within the Culebra cannot be screened out on low probability.

**Screening on Low Consequence**

Releases from plumes were determined using the following equations.

$$R_i = E_i \cdot a \cdot b \cdot cW_i \qquad (2)$$

Where:

Ri = Release from a single region, I, over a time period 'Δt'
Ei = Expected number of drilling intrusion into region I over the time period , Δt
= (Ai · $d_r$ · Δt )
Ai = Area of waste emplaced
$d_r$ = drilling rate per unit area per unit time period
Δt = time period
a = cross sectional area of an intruding borehole
b = thickness of waste region penetrated by borehole

cWi = concentration of waste (EPA units/$m^2$) in region I
= (Wi/(Ai · b)) ($10^{-6\ km}/m^2$)

Wi = the amount of dissolved waste partitioned to other units

Substituting the above definitions into Equation 2 gives us:

$$R_i = (A_i \cdot d \cdot \ \Delta t)\ (a \ \cdot \ b \ \cdot \ \frac{Wi}{A_i \cdot \ b})\ (10^{-6}\ \frac{km^2}{m^2}) \qquad (3)$$

Canceling terms reduces Equation 3 to:

$$R_i = (d \cdot \ \Delta t \ \cdot a \ \cdot \ Wi)\ (10^{-6}\ \frac{km^2}{m^2}) \qquad (4)$$

Equation 4 shows drilling rates, actinide concentrations, and the borehole cross-sectional areas are the major contributors to releases, and not the plume size.

For releases from two areas having different drilling rates and concentrations the above equation would be adapted by the following:

$R_T$ = $R_1 + R_2$

$$= [(A_1 \cdot d \cdot \ \Delta t)\ (a \ b_1 \cdot \ \frac{W_1}{A_1 \ b_1}) \ + \ (A_2 \cdot d \cdot \ \Delta t)\ (a \ b_2 \cdot \ \frac{W_2}{A_2 \ b_2})]\ (10^{-6}\ \frac{km^2}{m^2}) \qquad (5)$$

Canceling terms reduces equation 5 to:

$$R_T = [(d_1 \cdot \Delta t \cdot a \cdot W_1) + (d_2 \cdot \Delta t \cdot a \cdot W_2)](10^{-6} \frac{km^2}{m^2}) \tag{6}$$

Where:

$A_i$ = Area of waste partitioned into *n* number or plumes.
Wi = the amount of dissolved waste partitioned to each region

di = drilling rate per unit area, differs depending on whether plume is locate in shallow or deep zones defined in Table 2.

Marker Bed 139 and Culebra Dolomite, are here denoted as region $R_1$ and $R_2$, respectively.

Using Equation 6 and EPA releases to both units (listed in Table 3), cuttings releases from boreholes intersecting plumes in both MB139 and the Culebra were derived. These values are listed on Table 4. For this analysis it was assumed all waste partitioned into the plume gets taken up by a borehole 'plug' regardless of whether it is adsorbed to a solid, precipitated, in solution or colloidal. As a comparison, cuttings releases were calculated (in EPA units) using Equation 4 for 46.744 intrusions into the repository and listed on Table 5. It was assumed waste was uniformly distributed over the entire repository.

**Table 3. EPA Releases to the Culebra and MB 139 (.311 m Borehole Diameter)**

| **Scenario Number** - Time of Intrusion into Repository Intrusion Region | Number of Vectors with Releases | Releases (EPAUntis) Maximum, Minimum Median | Number of Vectors with Releases | Releases (EPAUntis) Maximum, Minimum Median |
|---|---|---|---|---|
| | **Culebra** | | **MB 139** | |
| S1 - Undisturbed (no intrusion) | 0 | NA | 1 | 1.28E-1 |
| S2 - 350 years - Intrusion into Waste Panel and Brine Pocket | 23 | 1.48<br>1.53E-7<br>7.39E-2 | 22 | 1.10E-2<br>1.73E-10<br>2.71E-4 |
| S3 - 1000 years - Intrusion into Waste Panel and Brine Pocket | 19 | 6.5E-1<br>1.52E-4<br>2.15E-2 | 18 | 3.67E-3<br>3.01E-9<br>9.56E-5 |

**Table 3. EPA Releases to the Culebra and MB 139 (.311 m Borehole Diameter)**

| | | | | |
|---|---|---|---|---|
| S4 - 350 years - Intrusion into Waste Panel only | 6 | 17.7<br>1.34E-2<br>1.34E-1 | 0 | NA |
| S5 - 1000 years - Intrusion into Waste Panel only | 6 | 16.0<br>1.35E-4<br>1.06E-1 | 1 | 1.57E-5 |

**Table 4. Releases from Boreholes Intesecting Plume in Culebra and Marker Bed 139 (0.311 m Borehole Diameter).**

**68.597 Boreholes per 10,000 years per $kM^2$ (rate for shallow borehole)**
**46.766 Boreholes per 10,000 years per $kM^2$ (rate for deep boreholes )**

| Scenario | EPA Releases from Culebra | EPA Release from MB 139 | Total EPA Releases |
|---|---|---|---|
| 1 | | | |
| One Value | 0.00e+00 | 4.55 E - 7 | 4.55 E-7 |
| 2 | | | |
| Maximum | 7.72 E-6 | 3.91 E-8 | 7.76 E-6 |
| Minimum | 7.98 E-13 | 6.15 E-16 | 7.98 E-13 |
| Median | 3.85 E-7 | 9.64 E-10 | 3.86 E-7 |
| 3 | | | |
| Maximum | 3.39 E-6 | 1.31 E-8 | 3.40 E-6 |
| Minimum | 7.93 E-10 | 1.07 E-14 | 7.93 E-10 |
| Median | 1.12 E-7 | 1.59 E-10 | 1.12 E-7 |
| 4 | | | |
| Maximum | 9.23 E-5 | 0 | 9.23 E-5 |
| Minimum | 6.99 E-8 | 0 | 6.99 E-8 |
| Median | 6.99 E-7 | 0 | 6.99 E-7 |
| 5 | | | |
| Maximum | 8.35 E-5 | 0 | 3.35 E-5 |
| Minimum | 7.04 E-10 | 5.58 E-11 | 7. 60 E-10 |
| Median | 5.53 E-7 | 0 | 5.53 E-7 |

**Table 5. Cuttings Releases (in EPA Units) at 1,000 and 10,000 years (.311 m Borehole Diameter)**

Releases from a 46.766 boreholes/kM²/10,000 year intersecting the repository - Assumption - Waste is Evenly Distributed over Repository.

| Time (years) | Repository Inventory (EPA Units) | Cutting Releases |
|---|---|---|
| 1,000 | 3.36 E+3 | **1.19 E-2** |
| 10,000 | 2.83 E+3 | **1.01 E-2** |

Results, listed on Tables 4 and 5, show cuttings releases from the repository are several orders of magnitude higher than cuttings releases from a contaminated plume within the Marker Beds and the Culebra. Consequently, any contribution from the repository cuttings will be far greater than that from boreholes intersecting plumes outside of the repository. It is recommended not to include borehole cuttings intersecting plumes within the Culebra and/or MB 139, as these will contribute insignificantly to the CCA CCDF .

## References

U.S. Department of Energy (DOE), June 1996. ***Draft*** - *Drilling Requirement and Practices in the Delaware Basin of New Mexico and Texas as Related to Potential inadvertent Human Intrusion int the Waste Isolation Pilot Plant (WIPP).*

U.S. Environmental Protection Agency (EPA), 1996. 40 CFR Part 194, *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plants's Compliance with the 40 CFR Part 191 Part 191 Disposal Regulations.*

# Appendix A.

Codes to Calculate Actinides Partitioned to Salado Units (e.g. Marker Beds) and Non-Salado Units

The 2-D numerical code BRAGFLO, respecitive BRAGFLO pre- and post-processors used to calculate flows in the Salado, non-Salado, borehole, and shaft (simulating a vertical slice of the model domain) are described in the following Analysis Plans:

> *Analysis Plan for the Salado Flow Calculations (Task 1) of the Performance Assessment Analyses Supporting the Compliance Certification Application,*
> SWCF File Number: WPO 36337

The 2-D numerical code NUTS, resepective NUTS pre- and post- processor used to actinide transport in the Salado, non-Salado, borehole, and shaft (simulating a vertical slice of the model domain) are described in the following Analysis Plans:

> *Analysis Plan for the Salado Transport Calculations (Task 2) of the Performance Assessment Analyses Supporting the Compliance Certification Application,* Version 00
> SWCF File Number: WPO 34797

The suite of 2-D SECO flow and transport numerical codes, pre- and post- processor used to calculate flow and actinide transport in the Culebra (simulating a horizontal slice of the model domain) are described in the following Analysis Plan:

> *Analysis Plan for the Culebra Flow and Transporot Calculation (Task 3) of the Performance Assessment Analyses Supporting the Compliance Certification Application,* Analysis Plan 019, Version 00
> SWCF File Number: WPO 37267

## Output Files Used to Determine 'Generic' Plume Sizes in the Culebra

Output Files: **Directory:** Disk$Carlos_CCA2:[ST2D.DATA.R1FM]
**File Name:** ST2D3_CCA_R1_V###.CDB

Given specific discharges and the range of input parameters for block lengths, fracture porosities, and partitioning coefficients ($K_d$s) Vectors 93 and 23 were determined as representing a set of conditions that would develop relatively large and small plumes, respectively, relative to other realizations.

## ALGEBRA Files Used to Pull-Off Dependant Variables from NUTs and BRAGFLO

Dependent variables from NUTs and BRAGFLO calculations at various locations of the modeled domain (defined on BRAGFLO grid , Figure 1 Appendix B) were 'pulled off' the data base using the following ALGEBRA files. A list of these dependent variables are on Table 1 Appendix B.

Algebra input and output files used to calculate integrated releases, fluxes (dependant parmeters) from NUTs runs.

Code: ALGEBRA Version Number:2.31z0 Platform:Alpha AXP Beatle Open VMS v6.1
Input file: **Directory:** U1:[JDMILLE.CCA.POSTALG]
**File Name:** PA_NUTS_ISO.inp
Output Files: **Directory:**
Disk$Tina_CCA3:[BF.JDMILLE.CCA.POSTALG.PA_NUTS.R1S%]
**File Name:** PA_NUTS_ISO_R1S%_V###.cdb
% = 1...5
# = 1...100

Table 1. Appendix A

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_$2$DKB300:[JDMILLE.CCA.POSTALG]PA_NUTS_ISO_PARAM.LIS;7


 Output parameters from ALGEBRA file PA_NUTS_ISO.INP (19 June 1996)


 Activities (integrated fluxes) across the repository boundary (EPA units)

   Param 001: Am-241, activity across repository boundary --> EPA1_REP
   Param 002: Pu-239, activity across repository boundary --> EPA2_REP
   Param 003: Pu-238, activity across repository boundary --> EPA3_REP
   Param 004: U--234, activity across repository boundary --> EPA4_REP
   Param 005: Th-230, activity across repository boundary --> EPA5_REP
   Param 006: Total activity across repository boundary ----> EPAT_REP

 Activities (integrated fluxes) into marker beds at repository (EPA units)

   Param 007: Am-241 in marker beds at north repository border -----> EPA1_MBN
   Param 008: Pu-239 in marker beds at north repository border -----> EPA2_MBN
   Param 009: Pu-238 in marker beds at north repository border -----> EPA3_MBN
   Param 010: U--234 in marker beds at north repository border -----> EPA4_MBN
   Param 011: Th-230 in marker beds at north repository border -----> EPA5_MBN

   Param 012: Am-241 in marker beds at south repository border -----> EPA1_MBS
   Param 013: Pu-239 in marker beds at south repository border -----> EPA2_MBS
   Param 014: Pu-238 in marker beds at south repository border -----> EPA3_MBS
   Param 015: U--234 in marker beds at south repository border -----> EPA4_MBS
   Param 016: Th-230 in marker beds at south repository border -----> EPA5_MBS

   Param 017: Am-241 in all marker beds at repository borders ------> EPA1_MBT
   Param 018: Pu-239 in all marker beds at repository borders ------> EPA2_MBT
   Param 019: Pu-238 in all marker beds at repository borders ------> EPA3_MBT
   Param 020: U--234 in all marker beds at repository borders ------> EPA4_MBT
   Param 021: Th-230 in all marker beds at repository borders ------> EPA5_MBT
   Param 022: Total activity in marker beds at repository borders --> EPA_MB_T

 Total flux (mRem/yr) in marker beds across 1-w boundary

   Param 023: Am-241 flux in marker beds at north 1-w boundary ----> F1LW_MBN
   Param 024: Pu-239 flux in marker beds at north 1-w boundary ----> F2LW_MBN
   Param 025: Pu-238 flux in marker beds at north 1-w boundary ----> F3LW_MBN
   Param 026: U--234 flux in marker beds at north 1-w boundary ----> F4LW_MBN
   Param 027: Th-230 flux in marker beds at north 1-w boundary ----> F5LW_MBN

   Param 028: Am-241 flux in marker beds at south 1-w boundary ----> F1LW_MBS
   Param 029: Pu-239 flux in marker beds at south 1-w boundary ----> F2LW_MBS
   Param 030: Pu-238 flux in marker beds at south 1-w boundary ----> F3LW_MBS
   Param 031: U--234 flux in marker beds at south 1-w boundary ----> F4LW_MBS
   Param 032: Th-230 flux in marker beds at south 1-w boundary ----> F5LW_MBS

   Param 033: Am-241 total flux in all marker beds, 1-w boundary --> F1LW_MBC
   Param 034: Pu-239 total flux in all marker beds, 1-w boundary --> F2LW_MBC
   Param 035: Pu-238 total flux in all marker beds, 1-w boundary --> F3LW_MBC
   Param 036: U--234 total flux in all marker beds, 1-w boundary --> F4LW_MBC
   Param 037: Th-230 total flux in all marker beds, 1-w boundary --> F5LW_MBC

 Total activity (integrated flux) in marker beds at 1-w boundary (EPA units)

   Param 038: Am-241 in all marker beds across north 1-w boundary --> E1LW_MBN
   Param 039: Pu-239 in all marker beds across north 1-w boundary --> E2LW_MBN
   Param 040: Pu-238 in all marker beds across north 1-w boundary --> E3LW_MBN
   Param 041: U--234 in all marker beds across north 1-w boundary --> E4LW_MBN
   Param 042: Th-230 in all marker beds across north 1-w boundary --> E5LW_MBN

   Param 043: Am-241 in all marker beds across south 1-w boundary --> E1LW_MBS
   Param 044: Pu-239 in all marker beds across south 1-w boundary --> E2LW_MBS
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   Param 045: Pu-238 in all marker beds across south 1-w boundary --> E3LW_MBS
   Param 046: U--234 in all marker beds across south 1-w boundary --> E4LW_MBS
   Param 047: Th-230 in all marker beds across south 1-w boundary --> E5LW_MBS

   Param 048: Am-241 in all marker beds across 1-w boundaries ------> E1LW_MBT
   Param 049: Pu-239 in all marker beds across 1-w boundaries ------> E2LW_MBT
   Param 050: Pu-238 in all marker beds across 1-w boundaries ------> E3LW_MBT
   Param 051: U--234 in all marker beds across 1-w boundaries ------> E4LW_MBT
   Param 052: Th-230 in all marker beds across 1-w boundaries ------> E5LW_MBT
   Param 053: Total activity in all marker beds at 1-w boundaries --> EPALWMBT

 Extent of radioactive penetration in marker beds outward from repository (m)

   Param 054: Am-241 zone length, MB 138 North ---------> XL1_M38N
   Param 055: Pu-239 zone length, MB 138 North ---------> XL2_M38N
   Param 056: Pu-238 zone length, MB 138 North ---------> XL3_M38N
   Param 057: U--234 zone length, MB 138 North ---------> XL4_M38N
   Param 058: Th-230 zone length, MB 138 North ---------> XL5_M38N

   Param 059: Am-241 zone length, Anhydrite A&B North --> XL1_AABN
   Param 060: Pu-239 zone length, Anhydrite A&B North --> XL2_AABN
   Param 061: Pu-238 zone length, Anhydrite A&B North --> XL3_AABN
   Param 062: U--234 zone length, Anhydrite A&B North --> XL4_AABN
   Param 063: Th-230 zone length, Anhydrite A&B North --> XL5_AABN

   Param 064: Am-241 zone length, MB 139 North ---------> XL1_M39N
   Param 065: Pu-239 zone length, MB 139 North ---------> XL2_M39N
   Param 066: Pu-238 zone length, MB 139 North ---------> XL3_M39N
   Param 067: U--234 zone length, MB 139 North ---------> XL4_M39N
   Param 068: Th-230 zone length, MB 139 North ---------> XL5_M39N

   Param 069: Am-241 zone length, MB 138 South ---------> XL1_M38S
   Param 070: Pu-239 zone length, MB 138 South ---------> XL2_M38S
   Param 071: Pu-238 zone length, MB 138 South ---------> XL3_M38S
   Param 072: U--234 zone length, MB 138 South ---------> XL4_M38S
   Param 073: Th-230 zone length, MB 138 South ---------> XL5_M38S

   Param 074: Am-241 zone length, Anhydrite A&B South --> XL1_AABS
   Param 075: Pu-239 zone length, Anhydrite A&B South --> XL2_AABS
   Param 076: Pu-238 zone length, Anhydrite A&B South --> XL3_AABS
   Param 077: U--234 zone length, Anhydrite A&B South --> XL4_AABS
   Param 078: Th-230 zone length, Anhydrite A&B South --> XL5_AABS

   Param 079: Am-241 zone length, MB 139 South ---------> XL1_M39S
   Param 080: Pu-239 zone length, MB 139 South ---------> XL2_M39S
   Param 081: Pu-238 zone length, MB 139 South ---------> XL3_M39S
   Param 082: U--234 zone length, MB 139 South ---------> XL4_M39S
   Param 083: Th-230 zone length, MB 139 South ---------> XL5_M39S

 Maximum values of radioactive penetration zones in marker beds (m)

   Param 084: Maximum Pu-239 penetration in north marker beds --> MAX2_MBN
   Param 085: Maximum U--234 penetration in north marker beds --> MAX4_MBN

   Param 086: Maximum Pu-239 penetration in south marker beds --> MAX2_MBS
   Param 087: Maximum U--234 penetration in south marker beds --> MAX4_MBS

 Integrated fluxes (Ci) in borehole at Rustler/Culebra (for PANEL calculations)

   Param 088: Am-241 int. flux up bh at Rustler/Culebra (el.713) --> A00AM241
   Param 089: Pu-239 int. flux up bh at Rustler/Culebra (el.713) --> A00PU239
   Param 090: Pu-238 int. flux up bh at Rustler/Culebra (el.713) --> A00PU238
   Param 091: U--234 int. flux up bh at Rustler/Culebra (el.713) --> A00U234
   Param 092: Th-230 int. flux up bh at Rustler/Culebra (el.713) --> A00TH230
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 Activities (integrated fluxes) up borehole (EPA units)

   Param 093: Am-241 up borehole at Magenta Dolomite (el.777) ---> EPA1BHMD
   Param 094: Pu-239 up borehole at Magenta Dolomite (el.777) ---> EPA2BHMD
   Param 095: Pu-238 up borehole at Magenta Dolomite (el.777) ---> EPA3BHMD
   Param 096: U--234 up borehole at Magenta Dolomite (el.777) ---> EPA4BHMD
   Param 097: Th-230 up borehole at Magenta Dolomite (el.777) ---> EPA5BHMD
   Param 098: Total activity up borehole at Magenta (el.777) ----> EPATBHMD

   Param 099: Am-241 up borehole at Rustler/Culebra (el.713) ----> EPA1BHRC
   Param 100: Pu-239 up borehole at Rustler/Culebra (el.713) ----> EPA2BHRC
   Param 101: Pu-238 up borehole at Rustler/Culebra (el.713) ----> EPA3BHRC
   Param 102: U--234 up borehole at Rustler/Culebra (el.713) ----> EPA4BHRC
   Param 103: Th-230 up borehole at Rustler/Culebra (el.713) ----> EPA5BHRC
   Param 104: Total activity up bh at Rustler/Culebra (el.713) --> EPATBHRC

 Activity down borehole at Castile/Brine interface (EPA units)

   Param 105: Total activity down bh at Castile/Brine (el.973) --> EPATBHCB

 Fluxes (mRem/yr) in shaft at Salado/Rustler interface

   Param 106: Am-241 flux up shaft at Salado/Rustler (el.661) ---> FL1SH_SR
   Param 107: Pu-239 flux up shaft at Salado/Rustler (el.661) ---> FL2SH_SR
   Param 108: Pu-238 flux up shaft at Salado/Rustler (el.661) ---> FL3SH_SR
   Param 109: U--234 flux up shaft at Salado/Rustler (el.661) ---> FL4SH_SR
   Param 110: Th-230 flux up shaft at Salado/Rustler (el.661) ---> FL5SH_SR

 Activity (integrated flux) in shaft at Rustler/Culebra interface (EPA units)

   Param 111: Am-241 up shaft at Rustler/Culebra (el.662) -----------> EPA1SHRC
   Param 112: Pu-239 up shaft at Rustler/Culebra (el.662) -----------> EPA2SHRC
   Param 113: Pu-238 up shaft at Rustler/Culebra (el.662) -----------> EPA3SHRC
   Param 114: U--234 up shaft at Rustler/Culebra (el.662) -----------> EPA4SHRC
   Param 115: Th-230 up shaft at Rustler/Culebra (el.662) -----------> EPA5SHRC
   Param 116: Total activity up shaft at Rustler/Culebra (el.662) --> EPATSHRC

 Volume-averaged isotope concentration (EPA units/m^3 brine) in waste panel

   Param 117: Am-241 vol-avg concentration in waste panel ---------> EPAC1_WP
   Param 118: Pu-239 vol-avg concentration in waste panel ---------> EPAC2_WP
   Param 119: Pu-238 vol-avg concentration in waste panel ---------> EPAC3_WP
   Param 120: U--234 vol-avg concentration in waste panel ---------> EPAC4_WP
   Param 121: Th-230 vol-avg concentration in waste panel ---------> EPAC5_WP
   Param 122: Total vol-avg isotope concentration in waste panel --> EPACT_WP

 Volume-avg isotope concentration (EPA units/m^3 brine) in rest of repository

   Param 123: Am-241 vol-avg concentration in rest of repository --> EPAC1_RR
   Param 124: Pu-239 vol-avg concentration in rest of repository --> EPAC2_RR
   Param 125: Pu-238 vol-avg concentration in rest of repository --> EPAC3_RR
   Param 126: U--234 vol-avg concentration in rest of repository --> EPAC4_RR
   Param 127: Th-230 vol-avg concentration in rest of repository --> EPAC5_RR
   Param 128: Total vol-avg isotope conc. in rest of repository ---> EPACT_RR

 Activity of dissolved mass of isotopes in waste panel (EPA units)

   Param 129: Am-241 dissolved mass activity in waste panel ---------> DMEPA1WP
   Param 130: Pu-239 dissolved mass activity in waste panel ---------> DMEPA2WP
   Param 131: Pu-238 dissolved mass activity in waste panel ---------> DMEPA3WP
   Param 132: U--234 dissolved mass activity in waste panel ---------> DMEPA4WP
   Param 133: Th-230 dissolved mass activity in waste panel ---------> DMEPA5WP
   Param 134: Total dissolved mass activity in waste panel ----------> DMEPATWP
```

```
 Activity of dissolved mass of isotopes in rest of repository (EPA units)

   Param 135: Am-241 dissolved mass activity in rest of repository --> DMEPA1RR
   Param 136: Pu-239 dissolved mass activity in rest of repository --> DMEPA2RR
   Param 137: Pu-238 dissolved mass activity in rest of repository --> DMEPA3RR
   Param 138: U--234 dissolved mass activity in rest of repository --> DMEPA4RR
   Param 139: Th-230 dissolved mass activity in rest of repository --> DMEPA5RR
   Param 140: Total dissolved mass activity in rest of repository ---> DMEPATRR

 Activity of undissolved mass of isotopes in waste panel (EPA units)

   Param 141: Am-241 undissolved mass activity in waste panel -------> PMEPA1WP
   Param 142: Pu-239 undissolved mass activity in waste panel -------> PMEPA2WP
   Param 143: Pu-238 undissolved mass activity in waste panel -------> PMEPA3WP
   Param 144: U--234 undissolved mass activity in waste panel -------> PMEPA4WP
   Param 145: Th-230 undissolved mass activity in waste panel -------> PMEPA5WP
   Param 146: Total undissolved mass activity in waste panel --------> PMEPATWP

 Activity of undissolved mass of isotopes in rest of repository (EPA units)

   Param 147: Am-241 undisslvd mass activity in rest of repository --> PMEPA1RR
   Param 148: Pu-239 undisslvd mass activity in rest of repository --> PMEPA2RR
   Param 149: Pu-238 undisslvd mass activity in rest of repository --> PMEPA3RR
   Param 150: U--234 undisslvd mass activity in rest of repository --> PMEPA4RR
   Param 151: Th-230 undisslvd mass activity in rest of repository --> PMEPA5RR
   Param 152: Total undisslvd mass activity in rest of repository ---> PMEPATRR

 Total activities of isotopes in marker beds (Ci)

   Param 153: Am-241 total activity in north marker beds --> TA1_MBN
   Param 154: Pu-239 total activity in north marker beds --> TA2_MBN
   Param 155: Pu-238 total activity in north marker beds --> TA3_MBN
   Param 156: U--234 total activity in north marker beds --> TA4_MBN
   Param 157: Th-230 total activity in north marker beds --> TA5_MBN

   Param 158: Am-241 total activity in south marker beds --> TA1_MBS
   Param 159: Pu-239 total activity in south marker beds --> TA2_MBS
   Param 160: Pu-238 total activity in south marker beds --> TA3_MBS
   Param 161: U--234 total activity in south marker beds --> TA4_MBS
   Param 162: Th-230 total activity in south marker beds --> TA5_MBS

   Param 163: Am-241 total activity in all marker beds ----> TA1_MBT
   Param 164: Pu-239 total activity in all marker beds ----> TA2_MBT
   Param 165: Pu-238 total activity in all marker beds ----> TA3_MBT
   Param 166: U--234 total activity in all marker beds ----> TA4_MBT
   Param 167: Th-230 total activity in all marker beds ----> TA5_MBT

 Total activities of isotopes in marker beds (EPA units)

   Param 168: Am-241 total activity in north marker beds --> TEPA1MBN
   Param 169: Pu-239 total activity in north marker beds --> TEPA2MBN
   Param 170: Pu-238 total activity in north marker beds --> TEPA3MBN
   Param 171: U--234 total activity in north marker beds --> TEPA4MBN
   Param 172: Th-230 total activity in north marker beds --> TEPA5MBN

   Param 173: Am-241 total activity in south marker beds --> TEPA1MBS
   Param 174: Pu-239 total activity in south marker beds --> TEPA2MBS
   Param 175: Pu-238 total activity in south marker beds --> TEPA3MBS
   Param 176: U--234 total activity in south marker beds --> TEPA4MBS
   Param 177: Th-230 total activity in south marker beds --> TEPA5MBS

   Param 178: Am-241 total activity in all marker beds ----> TEPA1MBT
   Param 179: Pu-239 total activity in all marker beds ----> TEPA2MBT
```

```
_$2$DKB300:[JDMILLE.CCA.POSTALG]PA_NUTS_ISO_PARAM.LIS;7

   Param 180: Pu-238 total activity in all marker beds ----> TEPA3MBT
   Param 181: U--234 total activity in all marker beds ----> TEPA4MBT
   Param 182: Th-230 total activity in all marker beds ----> TEPA5MBT

   Param 183: Total activity in all marker beds, north ----> TEPATMBN
   Param 184: Total activity in all marker beds, south ----> TEPATMBS
   Param 185: Total activity in all marker beds, overall --> TEPATMBT

 Total activities of isotopes in waste panel (EPA units)

   Param 186: Am-241 total activity in waste panel ----------> TEPA1_WP
   Param 187: Pu-239 total activity in waste panel ----------> TEPA2_WP
   Param 188: Pu-238 total activity in waste panel ----------> TEPA3_WP
   Param 189: U--234 total activity in waste panel ----------> TEPA4_WP
   Param 190: Th-230 total activity in waste panel ----------> TEPA5_WP
   Param 191: Total isotope activity in waste panel ---------> TEPAT_WP

 Total activities of isotopes in rest of repository (EPA units)

   Param 192: Am-241 total activity in rest of repository ---> TEPA1_RR
   Param 193: Pu-239 total activity in rest of repository ---> TEPA2_RR
   Param 194: Pu-238 total activity in rest of repository ---> TEPA3_RR
   Param 195: U--234 total activity in rest of repository ---> TEPA4_RR
   Param 196: Th-230 total activity in rest of repository ---> TEPA5_RR
   Param 197: Total isotope activity in rest of repository --> TEPAT_RR

 Fluxes (Ci/s) in borehole at Rustler/Culebra Interface

   Param 198: Am-241 flux up borehole at Rustler/Culebra (el.713) --> FL1BH_RC
   Param 199: Pu-239 flux up borehole at Rustler/Culebra (el.713) --> FL2BH_RC
   Param 200: Pu-238 flux up borehole at Rustler/Culebra (el.713) --> FL3BH_RC
   Param 201: U--234 flux up borehole at Rustler/Culebra (el.713) --> FL4BH_RC
   Param 202: Th-230 flux up borehole at Rustler/Culebra (el.713) --> FL5BH_RC

 Concentration (kg/m^3 brine) of isotopes in borehole at Rustler/Culebra

   Param 203: Am-241 concen. in bh at Rustler/Culebra (el.713) --> CON1BHRC
   Param 204: Pu-239 concen. in bh at Rustler/Culebra (el.713) --> CON2BHRC
   Param 205: Pu-238 concen. in bh at Rustler/Culebra (el.713) --> CON3BHRC
   Param 206: U--234 concen. in bh at Rustler/Culebra (el.713) --> CON4BHRC
   Param 207: Th-230 concen. in bh at Rustler/Culebra (el.713) --> CON5BHRC
```

```
  Param 180: Pu-238 total activity in all marker beds ----> TEPA3MBT
  Param 181: U--234 total activity in all marker beds ----> TEPA4MBT
  Param 182: Th-230 total activity in all marker beds ----> TEPA5MBT

  Param 183: Total activity in all marker beds, north ----> TEPATMBN
  Param 184: Total activity in all marker beds, south ----> TEPATMBS
  Param 185: Total activity in all marker beds, overall --> TEPATMBT

Total activities of isotopes in waste panel (EPA units)

  Param 186: Am-241 total activity in waste panel ----------> TEPA1_WP
  Param 187: Pu-239 total activity in waste panel ----------> TEPA2_WP
  Param 188: Pu-238 total activity in waste panel ----------> TEPA3_WP
  Param 189: U--234 total activity in waste panel ----------> TEPA4_WP
  Param 190: Th-230 total activity in waste panel ----------> TEPA5_WP
  Param 191: Total isotope activity in waste panel ---------> TEPAT_WP

Total activities of isotopes in rest of repository (EPA units)

  Param 192: Am-241 total activity in rest of repository ---> TEPA1_RR
  Param 193: Pu-239 total activity in rest of repository ---> TEPA2_RR
  Param 194: Pu-238 total activity in rest of repository ---> TEPA3_RR
  Param 195: U--234 total activity in rest of repository ---> TEPA4_RR
  Param 196: Th-230 total activity in rest of repository ---> TEPA5_RR
  Param 197: Total isotope activity in rest of repository --> TEPAT_RR

Fluxes (Ci/s) in borehole at Rustler/Culebra Interface

  Param 198: Am-241 flux up borehole at Rustler/Culebra (el.713) --> FL1BH_RC
  Param 199: Pu-239 flux up borehole at Rustler/Culebra (el.713) --> FL2BH_RC
  Param 200: Pu-238 flux up borehole at Rustler/Culebra (el.713) --> FL3BH_RC
  Param 201: U--234 flux up borehole at Rustler/Culebra (el.713) --> FL4BH_RC
  Param 202: Th-230 flux up borehole at Rustler/Culebra (el.713) --> FL5BH_RC

Concentration (kg/m^3 brine) of isotopes in borehole at Rustler/Culebra

  Param 203: Am-241 concen. in bh at Rustler/Culebra (el.713) --> CON1BHRC
  Param 204: Pu-239 concen. in bh at Rustler/Culebra (el.713) --> CON2BHRC
  Param 205: Pu-238 concen. in bh at Rustler/Culebra (el.713) --> CON3BHRC
  Param 206: U--234 concen. in bh at Rustler/Culebra (el.713) --> CON4BHRC
  Param 207: Th-230 concen. in bh at Rustler/Culebra (el.713) --> CON5BHRC
```

Code: SUMMARIZE Version Number:2.10 Platform:Alpha AXP Beatle Open VMS v6.1

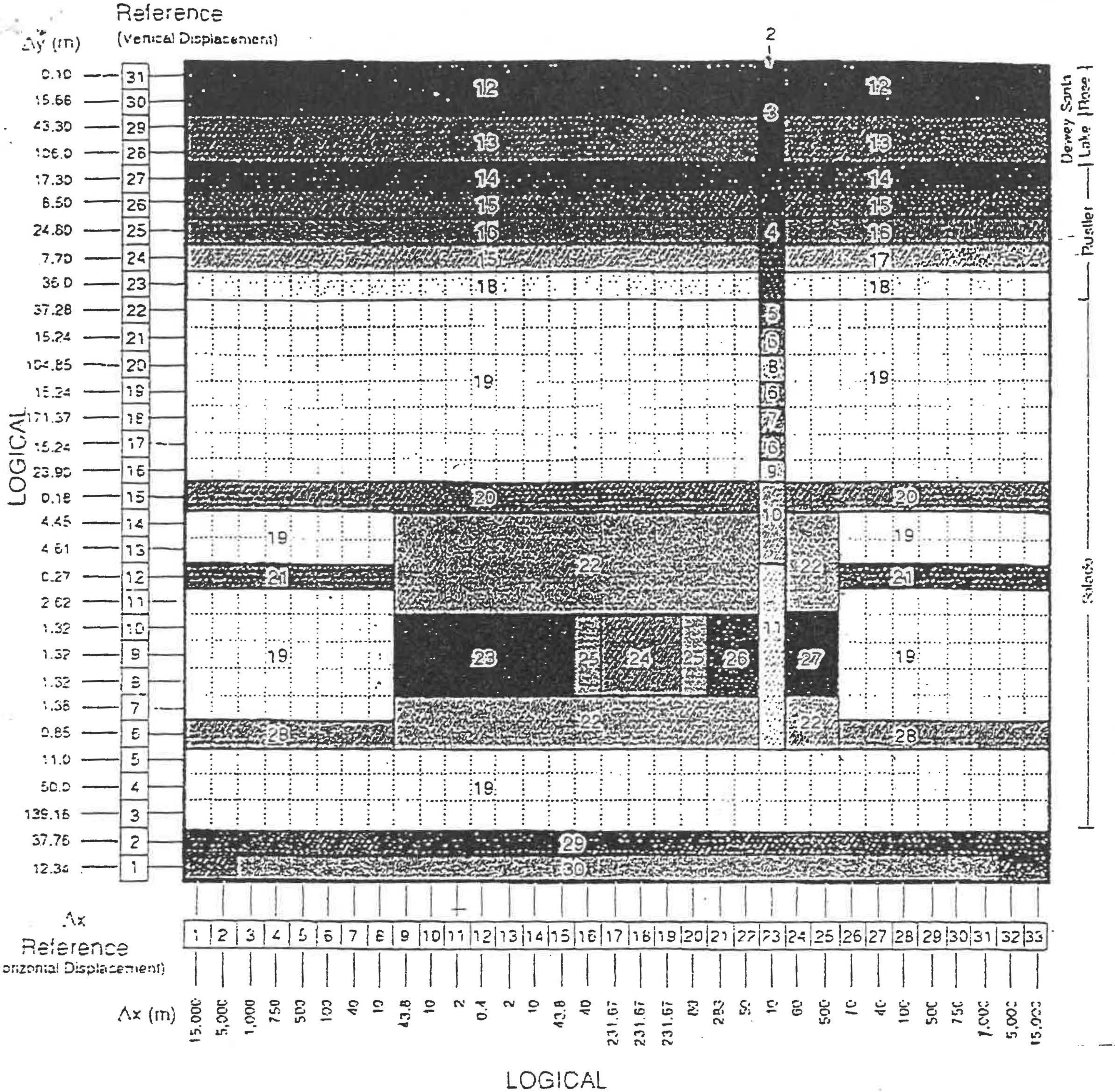
| | | |
|---|---|---|
| Input file: | **Directory:** | U1:[KMECONO.TEST.CCA.SUMM] |
| | **File Name:** | SM_CLEPA_10k_R1S%.INP<br>SM_RP_EPA_R1S%.INP<br>% = 1...5 |
| Output Files: | **Directory:** | U1:[KMECONO.TEST.CCA.SUMM.R1S%] |
| | **File Name:** | c1%_EPA.TBL |
| Input file: | **Directory:** | U1:[KMECONO.TEST.CCA.SUMM] |
| | **File Name:** | SM_RP_EPA_R1S%.INP<br>% = 1...5 |
| Output Files: | **Directory:** | U1:[KMECONO.TEST.CCA.SUMM.R1S%] |
| | **File Name:** | RP%_EPA.TBL |

Files created with SUMMARIZE, i.e. *.tbl files, were exported to a PC in order to perform simple data manipulation; (e.g. to determine minimum, maximum, mean, medians).

Code: EXEL Version Number: 5.0 Platform: Gateway 2000 - 4DX2-66V

# Appendix B.

Figures 1 and 2 are maps of BRAGFLO 'logical material identification' and 'logical mesh' grids used to determine actinide releases to Marker Beds, Rustler (Magenta and Culebra Dolomites) and Dewey Lake Formations. Dependant Parameters (listed in Table 1 Appendix A) were calculated by ALGEBRA runs using output from NUTs transport runs.



2. Shaft
3. Earth Fill
4. Rustler Clay Component
5. Asphalt
6. Concrete
7. Crushed Salt (Salado Salt Column)
8. Upper ~~SALADO~~ Compacked Clay
9. Lower ~~SALADO~~ Compacked Clay
10. Lower Clay Component
11. Concrete Monolith
12. Santa Rosa Formation
13. Dewey Lake Formation
14. Forty-niner Member
15. Magenta Dolomite Member
16. Tamarisk Member
17. Culebra Dolomite Member
18. Unnamed Lower Member
19. Halite
20. Marker Bed 138
21. Anhydrite Layer A&B
22. Disturbed Rock Zone
23. Waste Panel
24. Rest of Repository
25. Panel Closures
26. Operation Region
27. Experimental Area
28. Marker Bed 139
29. Castile Formation
30. Brine Reservoir

Figure 1

ELEMENT NUMBERS

GENMESH A-6.07ZO 10/09/95

LOGICAL mesh
Element Blocks Active:
11 of 11

↓Borehole

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 669 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 |
| 894 | 895 | 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 668 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 |
| 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 667 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 |
| 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 666 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 |
| 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 665 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 |
| 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 664 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 |
| 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 663 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 |
| 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 662 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 |
| 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 661 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 |
| 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 660 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 |
| 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 659 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 |
| 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 658 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 |
| 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 657 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 |
| 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 656 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 |
| 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 655 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 |
| 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 654 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 |
| 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 653 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 |
| 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 652 | 530 | 531 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 |
| 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 651 | 528 | 529 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 |
| 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 650 | 526 | 527 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 |
| 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 649 | 524 | 525 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 |
| 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 640 | 623 | 624 | 625 | 643 | 630 | 631 | 648 | 636 | 637 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 |
| 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 639 | 620 | 621 | 622 | 642 | 628 | 629 | 647 | 634 | 635 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 |
| 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 638 | 617 | 618 | 619 | 641 | 626 | 627 | 646 | 632 | 633 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 |
| 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 645 | 466 | 467 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 |
| 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 644 | 464 | 465 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 |
| 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 |
| 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
| 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 |
| 958 | 959 | 995 | 996 | 997 | 998 | 999 | 1000 | 100 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 101 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 | 102 | 1022 | 1023 | 960 | 961 |

MB 138

MB A/B

MB 139

LOGICAL

LOGICAL

Figure 2

Y

X

U1:[JEBEAN.NMVP]GENMESH_NMVP.CDB;2

BLOTCDB X-1.35ZO 10/12/95 10:26

B3