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Interoffice Memorandum

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PORFLOW INPUT TO SUPPORT THE DEVELOPMENT OF THE SDF FY13 SPECIAL ANALYSIS

Provided below is the data input to be used in the PORFLOW analysis conducted to support the FY13 Special Analysis (SA) for the performance of the Saltstone Disposal Facility (SDF) Saltstone Disposal Units (SDUs). Data not specifically specified in this memorandum are to be the same data used for the PORFLOW analysis conducted to support the response to Request for Additional Information (RAI) PA-8 in SRR-CWDA-2011-00044.

Infiltration Rate and Sand Drainage Layer Degradation

Table 1 provides the infiltration rate from the closure cap to be used for the SA. Table 1 provides Maximum, Average (nominal), and Minimum values to be used in the development of the flow cases to be run in PORFLOW. These values are obtained from Appendix K of WSRC-STI-2008-00244.

The infiltration rate affects the degradation of the Sand Drainage Layer (SDL) located above each of the SDUs. The degradation rate of the SDL for the infiltration rates provided in Table 1 is based on the analysis presented in WSRC-STI-2008-00244. The rate of degradation, indicated by the change in hydraulic properties, is provided in Table 2.

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Table 1
Estimated Infiltration Rates through the Closure Cap

Time after Closure (years)	Infiltration Rate		
	Maximum	Average	Minimum
0	0.00269	0.00042	0.00007
100	0.0277	0.00333	0.0003
180	0.367	0.0452	0.00376
220	0.459	0.0568	0.0047
300	0.677	0.171	0.0414
380	1.652	0.472	0.117
460	2.207	0.723	0.187
560	2.759	1.021	0.276
1,000	4.647	2.264	0.679
1,800	8.280	4.340	1.465
3,200	10.629	6.795	2.998
5,412	12.450	10.606	5.303
5,600	12.450	10.606	5.302
10,000	12.450	10.606	5.410

Table 2
Degradation of Sand Drainage Layer

Year	Maximum		Average		Minimum	
	Saturated Hydraulic Conductivity	Porosity	Saturated Hydraulic Conductivity	Porosity	Saturated Hydraulic Conductivity	Porosity
0	5.00E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
100	5.00E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
180	5.00E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
220	5.00E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
300	5.00E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
380	5.00E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
460	4.99E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
560	4.98E-02	4.17E-01	5.00E-02	4.17E-01	5.00E-02	4.17E-01
1,000	4.94E-02	4.16E-01	4.97E-02	4.17E-01	4.99E-02	4.17E-01
1,800	4.79E-02	4.14E-01	4.90E-02	4.16E-01	4.97E-02	4.17E-01
3,200	4.41E-02	4.09E-01	4.68E-02	4.13E-01	4.88E-02	4.15E-01
5,412	3.68E-02	3.99E-01	4.13E-02	4.05E-01	4.62E-02	4.12E-01
5,600	3.61E-02	3.98E-01	4.07E-02	4.05E-01	4.59E-02	4.11E-01
10,000	2.05E-02	3.77E-01	2.73E-02	3.87E-01	3.91E-02	4.02E-01
10,319	1.93E-02	3.76E-01	2.64E-02	3.85E-01	3.86E-02	4.02E-01
11,000	1.69E-02	3.73E-01	2.43E-02	3.83E-01	3.76E-02	4.00E-01
12,000	1.34E-02	3.68E-01	2.13E-02	3.78E-01	3.60E-02	3.98E-01
13,459	8.17E-03	3.61E-01	1.69E-02	3.73E-01	3.38E-02	3.95E-01
15,000	2.68E-03	3.54E-01	1.22E-02	3.66E-01	3.14E-02	3.92E-01
16,500	4.10E-05	3.50E-01	7.64E-03	3.60E-01	2.91E-02	3.89E-01
17,077	4.10E-05	3.50E-01	5.89E-03	3.58E-01	2.82E-02	3.88E-01
18,800	4.10E-05	3.50E-01	6.61E-04	3.51E-01	2.55E-02	3.84E-01
18,900	4.10E-05	3.50E-01	3.58E-04	3.50E-01	2.54E-02	3.84E-01
19,013	4.10E-05	3.50E-01	4.10E-05	3.50E-01	2.52E-02	3.84E-01
19,500	4.10E-05	3.50E-01	4.10E-05	3.50E-01	2.44E-02	3.83E-01
19,700	4.10E-05	3.50E-01	4.10E-05	3.50E-01	2.41E-02	3.82E-01
20,000	4.10E-05	3.50E-01	4.10E-05	3.50E-01	2.37E-02	3.82E-01
20,695	4.10E-05	3.50E-01	4.10E-05	3.50E-01	2.26E-02	3.80E-01
24,313	4.10E-05	3.50E-01	4.10E-05	3.50E-01	1.70E-02	3.73E-01
50,000	4.10E-05	3.50E-01	4.10E-05	3.50E-01	4.10E-05	3.50E-01
100,000	4.10E-05	3.50E-01	4.10E-05	3.50E-01	4.10E-05	3.50E-01

Reduction Capacity and Transition Pore Volumes

For this SA, the most recent recommended values for the reduction capacity in the cementitious materials will be used which are documented in SRNL-STI-2012-00596. Table 3 summarizes the parameters and the results of estimated pore volumes to initiate chemical transitions for the initial SRR-CWDA-2009-00017 (SDF PA), the RAI response to SP-8 (SRR-CWDA-2011-00044), and for this SA. The transition volumes recalculated in RAI SP-8 are used for this SA

except for the pore volumes required for transition from Reduced, Region 2 to Oxidized, Region 2 because of the change in the reduction capacity. The pore volume for transition from Reduced, Region 2 to Oxidized, Region 2 is considered to be proportional to the reduction capacity when all other parameters are the same. Thus, the pore volume for transition from Reduced, Region 2 to Oxidized, Region 2 was reduced to reflect the lower value for the reduction capacity.

Table 3
Pore Volumes Required for Chemical Transitions

Parameter	**SDF PA**	**RAI SP-8**	**This SA**
For Saltstone and Clean Cap			
Bulk Density, g/cc	1.26	1.01	1.01
Porosity, unitless	0.423	0.58	0.58
Reduction Capacity, meq e-/g	0.822	0.822	0.607
Pore Volumes, unitless			
Reduced Region 2 to Oxidized Region 2	2,806	1,653	1,220
Oxidized Region 2 to Oxidized Region 3	10,422	11,213	11,213
For SDU Concrete Containing Slag (note 1)			
Bulk Density, g/cc	2.21	2.21	2.21
Porosity, unitless	0.184	0.12	0.12
Reduction Capacity, meq e-/g	0.240	0.240	0.178
Pore Volumes, unitless			
Reduced Region 2 to Oxidized Region 2	3,230	4,953	3,673
Oxidized Region 2 to Oxidized Region 3	4,206	6,446	6,446

Note 1: The SDU concrete containing slag (from SDF PA) are:
SDU 1 and SDU 4 walls and floor,
SDU 2 roof, wall, floor, and upper mud mat (UMM)

Radionuclide Release and Transport

Radionuclide release from saltstone and transport through the cementitious materials and into the soil is controlled via the distribution coefficient (K_d values) which are dependent on the chemical conditions of the cementitious material and the soil. Table 4 presents the K_d values for the elements of concern in soils. The distribution coefficients in clayey and sandy soils are also presented in Table 4 for cementitious leachate impacted soils. Because of the large volume of saltstone within the SDUs, saltstone does not transition to oxidized Region 3, indicative of lower pH values, the leachate impacted clayey and sandy soil K_d values are utilized in the vadose zone – the area above the aquifer. Table 5 presents the distribution coefficients for cementitious materials under Reduced Region 2, Oxidized Region 2, and Oxidized Region 3 conditions.

The release of technetium, specifically Tc-99, from the saltstone grout and transport through the SDU concrete is modeled as a shrinking core developed to support the issuance of the SDF PA. Unlike the SDF PA model; however, the release of Tc-99 in a reducing environment is controlled by solubility rather than by K_d value. Once the cementitious material transitions to oxidizing

conditions the transport is controlled by the K_d value. The solubility value for technetium has been estimated to be 1.0E-08 moles/L for saltstone, clean cap and for SDU concrete containing slag based on SRNL-STI-2012-00769.

Table 4
Distribution Coefficients (K_d Values) for Elements in Soils

	Clayey Soil (Backfill) (mL/g)				Sandy Soil (Vadose) (mL/g)			
Element	**Without Leachate**	**Ref.**	**Leachate Impacted**	**Ref.**	**Without Leachate**	**Ref.**	**Leachate Impacted**	**Ref.**
Ac	8,500	a	12,750	a	1,100	a	1650	a
Ag	30	a	96	a	10	b	32	a
Al	1,300	a	1,950	a	1,300	a	1,950	a
Am	8,500	a	12,750	a	1,100	a	1,650	a
As	200	a	280	a	100	a	140	a
At	0.9	a	0.1	a	0.3	a	0	a
Ba	101	c	303	a	15	c	45	a
Bk	8,500	a	12,750	a	1,100	a	1,650	a
C	400	a	2,000	a	10	a	50	a
Cd	30	a	90	a	15	a	45	a
Ce	8,500	a	12,750	a	1,100	a	1,650	a
Cf	8,500	a	12,750	a	1,100	a	1,650	a
Cl	8	b	0.8	a	1	b	0.1	a
Cm	8,500	a	12,750	a	1,100	a	1,650	a
Co	100	a	320	a	40	a	128	a
Cr	400	b	560	a	1,000	b	1,400	a
Cs	50	a	50	a	10	a	10	a
Cu	70	a	224	a	50	a	160	a
Eu	8,500	a	12,750	a	1,100	a	1,650	a
Fe	400	a	600	a	200	a	300	a
Fr	50	a	50	a	10	a	10	a
Gd	8,500	a	12,750	a	1,100	a	1,650	a
H	0	e	0	a	0	e	0	a
Hg	1,000	a	3,200	a	800	a	2,560	a
I	0.9	a	0.1	a	0.3	a	0	a
K	25	a	25	a	5	a	5	a
Mn	200	a	280	a	15	a	21	a
N	0	e	0	a	0	f	0	e
Na	25	a	25	a	5	a	5	a
Nb	900	e	1260	a	160	e	224	a
Ni	30	a	96	a	7	a	22	a
Np	9	a	180	a	3	a	60	a
Pa	9	a	180	a	3	a	60	a
Pb	5,000	a	16,000	a	2,000	a	6,400	a

	Clayey Soil (Backfill) (mL/g)				Sandy Soil (Vadose) (mL/g)			
Element	**Without Leachate**	**Ref.**	**Leachate Impacted**	**Ref.**	**Without Leachate**	**Ref.**	**Leachate Impacted**	**Ref.**
Pd	30	a	96	a	7	a	22	a
Pm	0	f	0	f	0	f	0	f
Po	5,000	a	10,000	a	2,000	a	4,000	a
Pr	0	f	0	f	0	f	0	f
Pt	30	a	96	a	7	a	22	a
Pu	5,950	a	11,900	a	650	d	1,300	a
Ra	185	c	555	a	25	c	75	a
Rb	50	a	50	a	10	a	10	a
Re	1.8	a	0.2	a	0.6	a	0.1	a
Rh	0	f	0	f	0	f	0	f
Rn	0	f	0	a	0	f	0	a
Ru	0	f	0	f	0	f	0	f
Sb	2,500	a	3,500	a	2,500	a	3,500	a
Se	1,000	a	1,400	a	1,000	a	1,400	a
Sm	8,500	a	12,750	a	1,100	a	1,650	a
Sn	5,000	a	15,000	a	2,000	a	6,000	a
Sr	17	c	51	a	5	c	15	a
Tc	1.8	a	0.2	a	0.6	a	0.1	a
Te	1,000	a	1,400	a	1,000	a	1,400	a
Th	2,000	a	4,000	a	900	a	1,800	a
U	400	b	1,200	a	300	b	900	b
V	0	f	0	f	0	f	0	f
Y	8,500	a	12,750	a	1,100	a	1,650	a
Zn	30	a	90	a	15	a	45	a
Zr	2,000	a	4,000	a	900	a	1,800	a

a. SRNL-STI-2009-00473
b. SRNL-STI-2010-00493
c. SRNL-STI-2011-00011
d. SRNL-STI-2011-00672
e. ML073510127
f. Assigned value

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Table 5
Distribution Coefficients (K_d Values) for Elements in Cementitious Material

Element	Reduced Region 2 (mL/g)	Ref.	Oxidized Region 2 (mL/g)	Ref.	Oxidized Region 3 (mL/g)	Ref.
Ac	7,000	a	6,000	a	600	a
Ag	5,000	a	4,000	a	400	a
Al	7,000	a	6,000	a	600	a
Am	7,000	a	6,000	a	600	a
As	200	b	320	b	100	a
At	9	a	15	a	4	a
Ba	100	b	100	b	70	a
Bk	7,000	a	6,000	a	600	a
C	3,000	a	3,000	a	300	a
Cd	5,000	a	4,000	a	400	a
Ce	7,000	a	6,000	a	600	a
Cf	7,000	a	6,000	a	600	a
Cl	10	a	10	a	1	a
Cm	7,000	a	6,000	a	600	a
Co	5,000	a	4,000	a	400	a
Cr	1,000	a	10	a	1	a
Cs	20	a	20	a	10	a
Cu	5,000	a	4,000	a	400	a
Eu	7,000	a	6,000	a	600	a
F	10	a	10	a	1	a
Fe	7,000	a	6,000	a	600	a
Fr	20	a	20	a	10	a
Gd	7,000	a	6,000	a	600	a
H	0	c	0	c	0	c
Hg	5,000	a	300	a	100	a
I	9	a	15	a	4	a
K	20	a	20	a	10	a
Mn	100	a	100	a	10	a
N	10	a	10	a	1	a
Na	1	a	1	a	0.5	a
Nb	1,000	a	1,000	a	500	a
Ni	4,000	a	4,000	a	400	a
Np	10,000	a	10,000	a	5,000	a
Pa	10,000	a	10,000	a	5,000	a
Pb	5,000	a	300	a	100	a
Pd	5,000	a	4,000	a	400	a
Pm	0	c	0	c	0	c

Element	Reduced Region 2 (mL/g)	Ref.	Oxidized Region 2 (mL/g)	Ref.	Oxidized Region 3 (mL/g)	Ref.
Po	5,000	a	300	a	100	a
Pr	0	c	0	c	0	c
Pt	5,000	a	4,000	a	400	a
Pu	10,000	a	10,000	a	2,000	a
Ra	100	a	100	a	70	a
Rb	20	a	20	a	10	a
Re	5,000	a	0.8	a	0.5	a
Rh	0	c	0	c	0	c
Rn	0	c	0	c	0	c
Ru	0	c	0	c	0	c
Sb	1,000	a	1,000	a	100	a
Se	300	a	300	a	150	a
Sm	7,000	a	6,000	a	600	a
Sn	5,000	a	4,000	a	2,000	a
Sr	15	b	15	b	5	a
Tc	Note 1	-	0.8	b	0.5	a
Te	300	a	300	a	150	a
Th	5,000	a	10,000	a	2,000	a
U	2,500	a	1,000	c	100	c
V	0	c	0	c	0	c
Y	7,000	a	6,000	a	600	a
Zn	5,000	a	4,000	a	400	a
Zr	5,000	a	10,000	a	2,000	a

Note 1: In reducing cementitious materials technetium release is via solubility controls and for this SA the K_d value of 0.5 is used in oxidized regions

a. SRNL-STI-2009-00473
b. SRNL-STI-2010-00667
c. Assigned a value of zero

Hydraulic Properties of Cementitious Materials

The initial (undegraded) hydraulic properties of cementitious materials remain unchanged as presented in the SDF PA Table 4.2-16, except for the hydraulic conductivity and diffusion coefficient of saltstone and the clean cap. For saltstone and the clean cap, recent studies have indicated that the hydraulic conductivity and the diffusion coefficient should be revised.

The average saturated hydraulic conductivity from the most recent study, SRNL-STI-2012-00558, which considered various water to premix ratios with two different curing temperature profiles, will be used for the hydraulic conductivity of intact saltstone and clean cap, bounded by the operating band supported from current facility data. Based on analysis of current production

runs, X-CLC-Z-00050, the operating band for the water to premix ratio would be bounded by a low value of 0.59 and a high value of 0.64. For the water to premix ratio bounded by 0.59 and 0.64 the measured values for the saturated hydraulic conductivity is provided in Table 6, obtained from SRNL-STI-2012-00558, for saturated conditions and a high humidity exposure for two different curing temperature profiles. The average value for these runs is 6.4E-09 cm/sec and this value is considered the nominal value for the saturated hydraulic conductivity of intact saltstone and clean cap in the SDUs. Additional flow cases will consider two other values for the saturated hydraulic conductivity of saltstone and the clean cap. At the higher end of the spectrum, the conservative estimate value is based on 10 times the maximum reported value (4.5E-08 cm/sec) in Table 6, or 4.5E-07 cm/sec. At the lower end of the spectrum, the best estimate value is taken to be the minimum value reported in Table 6, 3.9E-10 cm/sec.

Table 6
Measured Hydraulic Conductivity from SRNL-STI-2012-00558

Final w/p ratio	**Hydraulic Conductivity (cm/s)**			
	Cell K Temperature Profile		**Cell F Temperature Profile**	
	Saturated	**Exposed Surface**	**Saturated**	**Exposed Surface**
0.59	1.7E-09	4.5E-09	1.4E-09	4.3E-09
0.59	1.9E-09	3.9E-10	3.6E-09	1.6E-09
0.6	1.7E-09	1.7E-09	4.1E-09	2.1E-09
0.6	2.1E-09	2.2E-09	3.7E-09	1.3E-09
0.64	3.2E-08	4.5E-08	7.0E-09	1.3E-09
0.64	9.6E-09	1.3E-08	5.0E-09	3.1E-09
Maximum	3.2E-08	4.5E-08	7.0E-09	4.3E-09
Average	8.2E-09	1.1E-08	4.1E-09	2.3E-09
Maximum	4.5E-08		7.0E-09	
Average	9.7E-09		3.2E-09	
Maximum	4.5E-08			
Average	6.4E-09			

Latest testing on simulated saltstone conducted by SIMCO Technologies, Inc., documented in SRNL-STI-2010-00515, indicates that the intrinsic diffusion coefficient (analogous to the effective diffusion coefficient used in PORFLOW) is less than 1.0E-08 cm^2/sec. This value of 1.0E-08 cm^2/sec will be used as the effective diffusion coefficient for intact saltstone and the clean cap.

For saltstone and the clean cap, the moisture characteristic curve (MCC) data presented in SRNL-STI-2011-00661, Table B.2 Recommended Characteristic Curves for Room Temperature Cure (20 ^{o}C) ARP/MCU Saltstone, is to be used.

Additional SDU Design Features

Included in this SA are additional design features that have the potential to provide additional pathways or fast flow zones for release.

Construction joints with water stops may degrade and provide a fast flow path out of the SDU. Table 7 provides the linear feet of joints to be used for each type of SDU. The modeling of these joints should be consistent with the model used in SRNL-STI-2012-00445. As in the modeling performed in SRNL-STI-2012-00445, the material medium within the joint is gravel; however, for differing flow cases the MCC will be either that of gravel or a relative permeability of 1 for all suction levels.

Table 7
Joint Length for Modeling

SDU	Length	Location
SDU 1	5,012 feet	Floor and Wall to Floor Interface
SDU 4	8,818 feet	Floor and Wall to Floor Interface
SDU 2	471 feet	Wall to Floor Interface

Columns are used to support the roof in Cells B through L of SDU 4 and in each of the SDU-2. For SDU 4 there are nine columns arranged in a 3 by 3 array in each cell. These columns are made of 10 inch diameter steel pipe, filled with lean concrete. For each SDU 2 there are forty-eight columns comprised of Type V concrete and reinforcing bar with an outside diameter of 14 inches. These columns are to be degraded in two foot segments along their length starting from the top and the bottom; with each successive segment degrading once the column above (or below) has degraded. To avoid unintended flow impact within the saltstone monolith when the columns degrade, the material in these columns is assumed to be saltstone material.

Cementitious Material Degradation

Cementitious material will be degraded based on the latest Cementitious Barrier Partnership (CBP) toolbox and other analytical methods. Three mechanisms should be considered: Sulfate attack, Decalcification, and Carbonation. Three cases should be considered for each mechanism: a Best Estimate (BE) value, a Nominal (N) value, and a Conservative Estimate (CE) value. Cementitious material degradation causes an increase in the hydraulic conductivity and diffusion coefficient as the material degrades to the surrounding soil conditions. This rate of degradation is to be linear in time.

For SDU 4, carbonation should be considered a viable mechanism for the degradation of saltstone and clean cap in the volume which contains the joist girder system employed for the construction of the permanent roof. The top two feet of saltstone, along with the existing clean cap, should be included in the volume of grout that can be degraded via carbonation.

For SDU 2, a High Density Polyethylene (HDPE) liner exists along the exterior of the walls and a composite layer of HDPE and a Geosynthetic Clay Liner (GCL) covers the roof and separates the UMM and Lower Mud Mat (LMM). The degradation of these barriers occurs prior to the diffusion of carbon (in the air), for degradation by carbonation, or calcium (in the groundwater), for degradation by decalcification, into the concrete. The degradation of these barriers is evaluated in SRNL-STI-2009-00115 and data extracted from Appendix E of SRNL-STI-2009-00115 is provided in Table 8.

Table 8
Degradation of HDPE and HDPE-GCL

Time Period (years)	HDPE Hydraulic Conductivity		HDPE-GCL Hydraulic Conductivity	
	Value (cm/sec)	Ratio to Initial Value	Value (cm/sec)	Ratio to Initial Value
0 - 50	5.87E-10	1	2.19E-11	1
900 – 1,000	6.04E-08	103	1.50E-09	68.5
1,400 – 1,600	9.69E-08	165	2.31E-09	105
9,500 – 10,000	6.44E-07	1,097	1.09E-08	498

To conservatively assess the performance of the HDPE and the HDPE-GGL, the initiation of the degradation of the SDU 2 wall and the roof is assumed to occur after 900 years and 1,400 years, respectively (corresponding to the time that the effectiveness of the barrier is reduced by a factor of approximately 100). Because the LMM is initially assumed to have soil properties, the degradation of the floor and UMM start at 1,400 years, following degradation of the HDPE-GGL separating the UMM and the LMM.

Flow Cases

Thirty-six flow cases are to be run to evaluate the impact on performance for different parameters. The parameters that are being evaluated are: infiltration rate (3 values) along with the attendant degradation of the SDL, saltstone initial saturated hydraulic conductivity (3 values), rate of cementitious material degradation (2 values), and MCC of the joints (2 values). Table 9 presents the thirty-six cases to be run. Two additional cases are also run to evaluate the impact of roof slope on the SDU-2, these cases F37 and F38 are also included in Table 9.

Table 9
Summary of Flow Cases

Case	Infiltration Rate	Cementitious Degradation Rate	Initial Saltstone Saturated Hydraulic Conductivity (cm/sec)	MCC for Joint
F-1	Average	Nominal	6.4E-09	Gravel
F-2	Average	Nominal	4.5E-07	Gravel
F-3	Average	Nominal	3.9E-10	Gravel
F-4	Average	BE	6.4E-09	Gravel
F-5	Average	BE	4.5E-07	Gravel
F-6	Average	BE	3.9E-10	Gravel
F-7	Average	Nominal	6.4E-09	Rel Per = 1 [a]
F-8	Average	Nominal	4.5E-07	Rel Per = 1
F-9	Average	Nominal	3.9E-10	Rel Per = 1
F-10	Average	BE	6.4E-09	Rel Per = 1
F-11	Average	BE	4.5E-07	Rel Per = 1
F-12	Average	BE	3.9E-10	Rel Per = 1
F-13	Maximum	Nominal	6.4E-09	Gravel
F-14	Maximum	Nominal	4.5E-07	Gravel
F-15	Maximum	Nominal	3.9E-10	Gravel
F-16	Maximum	BE	6.4E-09	Gravel
F-17	Maximum	BE	4.5E-07	Gravel
F-18	Maximum	BE	3.9E-10	Gravel
F-19	Maximum	Nominal	6.4E-09	Rel Per = 1
F-20	Maximum	Nominal	4.5E-07	Rel Per = 1
F-21	Maximum	Nominal	3.9E-10	Rel Per = 1
F-22	Maximum	BE	6.4E-09	Rel Per = 1
F-23	Maximum	BE	4.5E-07	Rel Per = 1
F-24	Maximum	BE	3.9E-10	Rel Per = 1
F-25	Minimum	Nominal	6.4E-09	Gravel
F-26	Minimum	Nominal	4.5E-07	Gravel
F-27	Minimum	Nominal	3.9E-10	Gravel
F-28	Minimum	BE	6.4E-09	Gravel
F-29	Minimum	BE	4.5E-07	Gravel
F-30	Minimum	BE	3.9E-10	Gravel
F-31	Minimum	Nominal	6.4E-09	Rel Per = 1
F-32	Minimum	Nominal	4.5E-07	Rel Per = 1
F-33	Minimum	Nominal	3.9E-10	Rel Per = 1
F-34	Minimum	BE	6.4E-09	Rel Per = 1
F-35	Minimum	BE	4.5E-07	Rel Per = 1
F-36	Minimum	BE	3.9E-10	Rel Per = 1
F-37	Same as F-1 but with a roof slop of 1.5% (SDU-2 only)			
F-38	Same as F-1 but with a roof slop of 2.5% (SDU-2 only)			

a Rel Per refers to relative permeability at all suction levels

Moisture Characteristic Curves (MCCs)

Table 10 provides a summary of the material to be used for the MCCs within the model. For cementitious material (concrete and saltstone), blended MCCs will be used to simulate the moisture retention capability of the material as it degrades to soil properties. For concrete the initial MCC is assumed to be high quality concrete to conservatively assess its moisture retention capability.

Table 10
Material MCC for Zones in the Model

SDU Feature	**PORFLOW Material**
SDU 1 and 4 Roof	Concrete [1]
SDU 1 and 4 Wall	Backfill
SDU 1 and 4 Floor	Concrete [1]
SDU 4 Column	Saltstone [2]
SDU 2 HDPE, Floor HDPE-GCL	Backfill
SDU 2 Roof HDPE-GCL	Backfill then Sand [3]
SDU 2 Roof, Wall, Floor, UMM	Concrete [1]
SDU 2 LMM	Lower Vadose
SDU 2 Column	Saltstone
Degraded SDU Roof, Wall, Columns	Backfill
Degraded SDU Floor and UMM	Lower Vadose
Preferential flow paths (joints)	Gravel [4]
Saltstone and clean cap	Saltstone [2]

1 WSRC-TR-2006-00198, High quality concrete.
2 SRNL-STI-2011-00661, Table B.2 Recommended Characteristic Curves for Room Temperature Cure (20 ^{o}C) ARP/MCU Saltstone.
3 Roof HDPE_GCL initially has Backfill MCC until at complete degradation it has Sand MCC, to be the same as the sand drainage layer above the HDPE_GCL.
4 Sensitivity cases also consider a relative permeability of 1 at all suction levels.

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