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Evaluation of Saltstone Disposal Structures 3A, 3B, 5A, and 5B As-Built Conditions to Support Unreviewed Waste Management Question Evaluation

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ACRONYMS

C&WDA	Closure and Waste Disposal Authority
CA	Composite Analysis
DCF	Design Change Form
DCR	Document Control Register
GCL	Geosynthetic Clay Liner
HDPE	High Density Polyethylene
NCR	Non-Conformance Report
PA	Performance Assessment
SDDR	Supplier Deviation Disposition Request
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SRS	Savannah River Site
SSC	Structures, Systems and Components
UWMQ	Unreviewed Waste Management Question
UWMQE	Unreviewed Waste Management Question Evaluation
WD	Waste Determination

1.0 PURPOSE

The purpose of this document is to support the issuance of the Unreviewed Waste Management Question Evaluation (UWMQE) to assess the as-built conditions as documented herein of Saltstone Disposal Units (SDUs) Cells 3A, 3B, 5A, and 5B against the design features modeled in the *Performance Assessment* (PA) *for the Saltstone Disposal Facility* (SDF) *at the Savannah River Site* (SRS). [SRR-CWDA-2009-00017] Activities or conditions that occur after this UWMQE is approved will be evaluated using Manual S4, Procedure ENG 46, *LW Unreviewed Waste Management Question (UWMQ).*

2.0 PROPOSED ACTIVITY

The proposed activity is to accept as-built conditions SDUs 3A/3B and 5A/5B described herein.

3.0 BACKGROUND

SDUs 3 and 5 consists of four cylindrical concrete cells, 3A/3B and 5A/5B (Figure 3.0-1), approximately 150 feet in diameter and 22-feet tall on top of a lower (Type II) concrete mud mat (Figure 3.0-2), and an upper (Type II) concrete (Figure 3.0-3) mud mat. A high-density polyethylene (HDPE) and geosynthetic clay liner (GCL) are placed in between the mud mats. Each cell has a nominal capacity of 2.9 million gallons. [SRR-CWDA-2009-00017]

Figure 3.0-1: Typical Cylindrical Concrete Disposal Unit

Figure 3.0-2: Typical Lower Mud Mat

Figure 3.0-3: Typical Upper Mud Mat

Each cell is constructed of approximately 12-inch thick Class III sulfate resistant poured concrete floors, 8-inch thick wall panels, and an 8-inch thick roof. The concrete walls are cast in beds (Figure 3.0-4), tilted up onto the poured concrete floor approximately 6 inches apart (Figure 3.0-5) with a closure strip of poured concrete between each wall panel. [SRR-CWDA-2009-00017]

Figure 3.0-4: Typical Wall Panel Casting

Figure 3.0-5: Typical Wall Panel Tilt-up Construction

After the walls are set, the (Class III sulfate resistant) concrete roof is cast and tied into the walls (Figure 3.0-6). Finally, pre-stressing wires are wrapped around the walls and locked in place with an application of shotcrete. The pre-stressing wires provide hoop stresses to counteract the forces on the walls when under hydrostatic load.

Figure 3.0-6: Typical Wall Reinforcing Bar Tie-In to Roof

During construction, Supplier Deviation Disposition Requests (SDDRs), Non-Conformance Reports (NCRs), or Design Change Forms (DCF's) were submitted to request changes to the baseline design. If approved by SRS, the changes were implemented in the field as described in the documentation. These changes are screened against the Manual S4 ENG 46 requirements document (SRR-CWDA-2011-00196), which identifies the items that maybe an impact to the SDF PA, *Savannah River Site DOE 435.1 Composite Analysis* (CA) (SRNL-STI-2009-00512), or the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site* (WD) (DOE-WD-2005-001), and require further evaluation. A single NCR (2013-NCR-15-DZC-0001) related to the disposal cells was generated as described in Section 5.2.1. The complete listing of Design Change Forms (DCF's) and SDDRs and their screening results are summarized in Table 3.0-1. DCF's and SDDR's were grouped as follows. Items that did not have the potential to impact the conclusions in the PA are designated "Neg." Items that have the potential to impact the PA are designated "Pos."

Table 3.0-1: Changes from Design Basis and Screening Results

DCR ID	Rev	Rev Date	Doc Type	Title	UWMQ Screening Results
C-DCF-Z-00141	0	1/12/2010	DCF	MATERIAL GAGE CHANGED FROM 10 GA TO 12 GA FOR CMP	Neg
C-DCF-Z-00145	0	3/29/2010	DCF	CONCRETE COVER FOR FLOOR AND WALLS REINFORCING STEEL FOR CELLS 3 AND 5	Neg
C-DCF-Z-00159	0	4/5/2011	DCF	MUDMAT BLOCKOUT FOR LCL BOX FOR CELL3A	Neg
C-DCF-Z-00166	0	6/13/2011	DCF	EMBEDDED PLATES LOCATIONS ON WALL PANELS FOR CELLS 3A, 3B & 5A, 5B	Neg
C-DCF-Z-00171	1	11/28/2012	DCF	REV.1 OF THIS DCF VOIDS PER THE ACTIVE VENT SYSTEM IS NOT REQUIRED FOR MOD 1 OPERATION CELL 3A, 3B, 5A & 5B ROOF LOAD FOR PVC VENT SYSTEM	Neg
C-DCF-Z-00171	0	8/10/2011	DCF	CELL 3A, 3B, 5A & 5B ROOF LOAD FOR PVC VENT SYSTEM	Neg
C-DCF-Z-00174	1	11/28/2012	DCF	EMBEDDED PLATE MARK NUMBER CORRECTION AND RELOCATION OF DRAIN LINE SUPPORT EMBEDDED PLATES FOR ROOF OF CELL 3A/B AND 5A/B	Neg
C-DCF-Z-00174	0	11/14/2011	DCF	EMBEDDED PLATE MARK NUMBER CORRECTION AND RELOCATION OF DRAIN LINE SUPPORT EMBEDDED PLATES FOR ROOF OF CELL 3A/B AND 5A/B	Neg
C-DCF-Z-00203	3	12/6/2012	DCF	SHEET DRAIN MATERIAL TYPES AND QUANTITIES FOR SDU 3A, 3B, 5A & 5B	Neg
C-DCF-Z-00203	2	12/5/2012	DCF	SHEET DRAIN MATERIAL TYPES AND QUANTITIES FOR SDU 3A, 3B, 5A & 5B	Neg
C-DCF-Z-00203	1	11/16/2012	DCF	SHEET DRAIN MATERIAL TYPES AND QUANTITIES FOR SDU 3A, 3B, 5A & 5B	Neg
C-DCF-Z-00203	0	4/11/2012	DCF	SHEET DRAIN MATERIAL TYPE AND QUANTITIES FOR SDU 3A, 3B, 5A & 5B	Neg
C-DCF-Z-00215	2	1/24/2013	DCF	SDU 6 EARLY TIE-IN TO SDU 3&5 STRUCTURAL SUPPORT DESIGN FOR GROUT FILL LINE	Neg
C-DCF-Z-00215	1	1/16/2013	DCF	SDU 6 EARLY TIE-INS TO SDU 3&5 STRUCTURAL SUPPORT DESIGN FOR GROUT FILL LINE	Neg

Table 3.0-1: Changes from Design Basis and Screening Results (Continued)

DCR ID	Rev	Rev Date	Doc Type	Title	UWMQ Screening Results
C-DCF-Z-00215	0	12/26/2012	DCF	SDU 6 EARLY TIE-IN STRUCTURAL SUPPORT DESIGN FOR GROUT FILL LINE	Neg
C-DCF-Z-00217	0	6/14/2012	DCF	ANCHOR BOLT REPAIR AT PIER FOR COLUMN SUPPORT TC-6	Neg
C-DCF-Z-00221	0	7/23/2012	DCF	ADDITION OF EC-66 COATING FOR INTERNAL CURBS OF SDU 3A, 3B, 5A AND 5B	Neg
C-DCF-Z-00223	1	2/5/2013	DCF	MODIFYING SUPPORTS ,RELEASING HOLDS AND ADDING ADDITIONAL SUPPORTS FOR THE GROUT LINE, DRAIN-WATER LINE, VENT LINE AND CABLE TRAY SERVICING SDU 3/5 (SEE REA 351)	Neg
C-DCF-Z-00223	0	12/4/2012	DCF	MODIFYING SUPPORTS ,RELEASING HOLDS AND ADDING ADDITIONAL SUPPORTS FOR THE GROUT LINE, DRAIN-WATER LINE, VENT LINE AND CABLE TRAY SERVICING SDU 3/5 (SEE REA 351)	Neg
C-DCF-Z-00224	1	1/16/2013	DCF	SDU 6 EARLY TIE-IN SUPPORT DESIGN FOR DRAINWATER RETURN LINE	Neg
C-DCF-Z-00224	0	12/21/2012	DCF	SDU 6 EARLY TIE-IN SUPPORT DESIGN FOR DRAINWATER RETURN LINE	Neg
C-DCF-Z-00226	0	11/14/2012	DCF	MODIFICATION TO WEEKLY SETTLEMENT SURVEY SCHEDULE AFTER HYDROTEST FOR SDU 3&5	Neg
C-DCF-Z-00228	1	2/5/2013	DCF	SDU 3 & 5 COMMODITY SUPPORT BRIDGE MODIFICATIONS	Neg
C-DCF-Z-00228	0	12/21/2012	DCF	SDU 3 & 5 COMMODITY SUPPORT BRIDGE MODIFICATIONS	Neg
C-DCF-Z-00230	0	11/28/2012	DCF	REPLACE POWER FLOAT FINISH REQUIREMENT WITH BULL FLOAT FINISH ON FLOORS & ROOFS OF SDU 3 & 5	Neg
C-DCF-Z-00235	1	1/16/2013	DCF	SDU 3-5 GROUT AND DRAIN LINE BRIDGE COLUMN SUPPORT MODIFICATIONS	Neg
C-DCF-Z-00235	0	12/21/2012	DCF	SDU 3-5 GROUT AND DRAIN LINE BRIDGE COLUMN SUPPORT MODIFICATIONS	Neg

Table 3.0-1: Changes from Design Basis and Screening Results (Continued)

DCR ID	Rev	Rev Date	Doc Type	Title	UWMQ Screening Results
C-DCF-Z-00236	0	2/13/2013	DCF	EMBEDDED PLATES MODIFICATION FOR SDU 3 AND 5	Neg
C-DCF-Z-00239	0	1/16/2013	DCF	GROUT & DRAIN LINE PIPING SUPPORTS	Neg
C-DCF-Z-00240	0	1/16/2013	DCF	ELECTRICAL EQUIPMENT SUPPORT MODIFICATIONS FOR SDU 3A, 3B, 5A & 5B (REA - S&Z 377 & 248)	Neg
C-DCF-Z-00241	0	2/21/2013	DCF	SHIELDING PLUG DESIGN FOR ABANDONED T/C PLUG, MODIFICATION FOR CAMERA PORT PLUG FOR VAULT 3A, 3B, 5A & 5B AND MODIFICATION FOR HATCH COVER	Neg
C-DCF-Z-00242	0	2/14/2013	DCF	SDU 3 & 5 NFPA 69 DEFLAGRATION MODIFICATIONS	Neg
C-DCF-Z-00243	0	2/20/2013	DCF	DURACOOL 1 COATING FOR THE SDU 3A, 3B, 5A & 5B	Neg
C-DCF-Z-00244	0	2/5/2013	DCF	SDU 3/5 - ADDITIONAL DRAIN-WATER PIPE SUPPORT (REA S&Z-430)	Neg
C-DCF-Z-00245	2	4/2/2013	DCF	SDU 3&5 13.8KV DIRECT BURIED LINES/CABLES	Neg
C-DCF-Z-00245	1	3/14/2013	DCF	SDU 3&5 13.8KV DIRECT BURIED LINES/CABLES	Neg
C-DCF-Z-00245	0	2/14/2013	DCF	SDU 3&5 13.8KV DIRECT BURIED LINES/CABLES	Neg
C-DCF-Z-00246	0	2/12/2013	DCF	SDU 3A, B, 5A & 5B GROUT HEIGHT MARKER LOCATIONS AND LABELS	Neg
C-DCF-Z-00247	0	2/20/2013	DCF	CORE DRILL FOR STILLING WELL	Neg
C-DCF-Z-00251	0	3/6/2013	DCF	SDU 3-5 GROUT AND DRAIN LINE BRIDGE COLUMN SUPPORT MODIFICATIONS	Neg
C-DCF-Z-00256	0	3/27/2013	DCF	ADD REFERENCE OF PIPE SUPPORT QUALIFICATION OF DRAIN-WATER & GROUT LINE TIE-IN OF SDU 3&5 TO SDU 2 TO DRAWING	Neg
E-DCF-Z-00278	0	9/15/2011	DCF	210-Z ICR, INSTALL TWO-1" CONDUITS BETWEEN PLC REPEATER PANELS AND WIREWAY	Neg
E-DCF-Z-00315	1	4/25/2013	DCF	SDU 3 & 5 KV, DIRECT BURIED LINES/CABLES	Neg
E-DCF-Z-00315	0	2/14/2013	DCF	SDU 3 & 5 KV, DIRECT BURIED LINES/CABLES	Neg
J-DCF-Z-00524	1	3/14/2013	DCF	ADDITION OF SDU 3/5 DRAINWATER FLOWMETERS	Neg
J-DCF-Z-00524	0	12/10/2012	DCF	ADDITION OF SDU 3/5 DRAINWATER FLOWMETERS	Neg

Table 3.0-1: Changes from Design Basis and Screening Results (Continued)

DCR ID	Rev	Rev Date	Doc Type	Title	UWMQ Screening Results
J-DCF-Z-00586	0	2/7/2013	DCF	DRAINWATER COLLECTION SYSTEM ASI SEGMENT DRAWING	Neg
J-DCF-Z-00587	0	3/26/2013	DCF	SDU 3/5, CCTV COAX CABLE ROUTING CHANGE INSIDE 210-Z	Neg
M-DCF-Z-00378	0	7/17/2012	DCF	SDU 3/5 PASSIVE VENTILATION HOUSING UPDATE	Neg
M-DCF-Z-00393	0	11/26/2012	DCF	SDU 3/5 PASSIVE VENTILATION HOUSING QIP CHANGE	Neg
M-DCF-Z-00413	0	2/19/2013	DCF	SDU 3/5 GROUT PIPE AND DRAINWATER RETURN PIPE TIE-IN HOLD REMOVAL	Neg
P-DCF-Z-00082	0	8/9/2012	DCF	SDU 3-5 DRAINWATER PIPE EXPANSION LOOP MOD. PER REA-210	Neg
P-DCF-Z-00086	1	11/15/2012	DCF	SDU 3 & 5 PASSIVE VENT DOP SMOKE INJECTION PORTS AND SYSTEM MOISTURE SEPARATOR DRAIN LINES	Neg
P-DCF-Z-00086	0	6/14/2012	DCF	SDU 3 & 5 PASSIVE VENT DOP SMOKE INJECTION PORTS AND SYSTEM MOISTURE SEPARATOR DRAIN LINES	Neg
P-DCF-Z-00089	0	2/6/2013	DCF	REVISE DETAIL 7	Neg
P-DCF-Z-00091	0	2/5/2013	DCF	SDU 3/5 - REVISE GROUT FILL PORT FROM VICTAULIC TO FLANGED CONNECTION	Neg
P-DCF-Z-00093	0	2/5/2013	DCF	SDU 3/5 STRESS ANAYLISIS RECONCILIATION	Neg
P-DCF-Z-00095	0	2/5/2013	DCF	GROUT PIPE RELOCATION DUE TO STEEL INTERFERENCE	Neg
P-DCF-Z-00096	0	2/12/2013	DCF	SDU 3/5 GROUT PIPE AND DRAINWATER RETURN PIPE TIE-IN HOLD REMOVAL	Neg
P-DCF-Z-00097	0	2/28/2013	DCF	SDU 3/5 GROUT PIPE VICTAULIC COUPLING ENGINEERED FULL SEAL ENCLOSURE	Neg
9857	NA	12/16/2009	SDDR	RISER OUTFALL STRUCTURE	Neg

Table 3.0-1: Changes from Design Basis and Screening Results (Continued)

DCR ID	Rev	Rev Date	Doc Type	Title	UWMQ Screening Results
11055	NA	6/8/2011	SDDR	DUE TO THE AMOUNT OF REINFORCING STEEL THERE IS A CONGESTION WHICH RESULTS IN CLEAR SPACE BETWEEN BARS WHICH IS LESS THAN DESCRIBED IN THE ACI 318 CODE	Pos
11076	NA	6/7/2011	SDDR	UPPER MUD MAT AT CELL 3B	Neg
11077	NA	6/7/2011	SDDR	DELTE THE REQUIREMENT TO POWER FLOAT THE TANK FLOORS	Neg
11099	NA	6/15/2011	SDDR	UPPER MUD MAT 5A	Neg
11102	NA	6/16/2011	SDDR	CONGESTION IN CLEAR SPACE	Pos
11165	NA	8/29/2011	SDDR	CRACKS DEVELOPED IN 3A & 3B UPPER MUD MAT REQUIRING REPAIR	Neg
11269	NA	8/23/2011	SDDR	CASTING BED PANEL 28B	Pos
11272	NA	8/24/2011	SDDR	TANK 5B FLOOR SLAB POUR	Pos
11275	NA	9/15/2011	SDDR	CASTING BED 2 PANEL B	Pos
11305	NA	9/28/2011	SDDR	CASTING BED PANEL 14E	Pos
11307	NA	9/14/2011	SDDR	TRUCK #6780772, DELIVERY TICKET #37715203 HAD 97 REVOLUTIONS INDICATED ON THE COUNTER AT THE 5:00 AM ARRIVAL	Pos
11339	NA	10/5/2011	SDDR	TANK 5B FLOOR SLAB POUR	Pos
11362	NA	10/18/2011	SDDR	TANK 3B WALK DOWN	Neg
11372	NA	11/18/2011	SDDR	RMXHLECFBCC 4000 PSI 2" LINE PUMP AI	Neg
11393	NA	11/18/2011	SDDR	TANK 5A COLUMN #37 HAS A VIBRATOR HEAD PROTRUDING OUT OF THE CONCRETE	Pos
11404	NA	11/11/2011	SDDR	EDGE FORM REMOVAL OF TANK 5A	Neg
11432	NA	1/25/2012	SDDR	WATERSTOP AIR TEST TUBE BLOCKAGE	Neg

Table 3.0-1: Changes from Design Basis and Screening Results (Continued)

DCR ID	Rev	Rev Date	Doc Type	Title	UWMQ Screening Results
11511	NA	1/27/2012	SDDR	BREAK REPORT NOT MEETING SPECIFICATION C-SPP-Z-00007 RV 2	Pos
11539	NA	5/3/2012	SDDR	SLUMP NOT MEETING SPECIFICATION C-SPP-Z-00007 REV. 2 RANGE 4" TO 8"	Pos
11632	NA	5/3/2012	SDDR	CROM DRAWING SH15 OF 21	Neg
11679	NA	5/2/2012	SDDR	SRR0000427-79-A-MDM P6 STEP #15, HOLD POINT 14 STATES INSPECT FOR IMPERFECTIONS	Neg
11700	NA	7/2/2012	SDDR	SLUMP RANGE FOR SPECIFICATION	Pos
11760	NA	7/26/2012	SDDR	WATER TIGHT TANK DESIGN	Neg
11808	NA	8/10/2012	SDDR	REPAIR OF DAMAGED LOWER MUDMAT ON TANK 3B	Neg
11924	NA	11/28/2012	SDDR	TANK 5A CYLINDERS	Pos
12004	NA	12/13/2012	SDDR	CORRECTLY INSTALL STILLING WELL ROOF EMBED PLATES	Neg

Note: List retrieved from the site *Document Control Register (DCR), a *controlled index* computer system for indexing and distributing engineering documents (managed within Document and Information Services).

4.0 RELEVANT DESIGN FEATURES

Design features modeled in the SDF PA (SRR-CWDA-2009-00017) that are potential impact items identified in Table 3.0-1 and are salient to this UWMQE are covered in Section 5 as follows:

Section 5.1: Materials of Construction

- 5.1.1: Concrete Slump Outside of Specification Due to Add Mixture (SDDR 11269 and SDDR 11305)
- 5.1.2: Concrete Slump Outside of Specification Due to Higher Than Expected Moisture Content in Aggregate (SDDR 11539)
- 5.1.3: Concrete Air Content Outside of Specification – High (SDDR 11275)
- 5.1.4: Concrete Air Content Outside of Specification – Low (SDDR 11700)

Section 5.2: Critical Dimensions

- 5.2.1: Roof Slope Tolerance (2013-NCR-15-DZC-0001)

Section 5.3: Codes and Standards Compliance

- 5.3.1: Floor Slab Reinforcing Bar Installed with Less Clearance than Allowed by Code (SDDR 11055 and SDDR 11102)
- 5.3.2: Field Cured Cylinders Improperly Cured (SDDR 11511)
- 5.3.3: Concrete Delivery Truck Exceeded Revolutions Required by Code (SDDR 11272, SDDR 11307 and SDDR 11339)

Section 5.4: Inadvertent Events

- 5.4.1: Concrete Consolidation Vibrator Wedged in Reinforcing Bar During Concrete Placement (SDDR 11393)

Modeled features other than those described above (e.g., elevations, penetrations, etc.) were not changed during construction of these disposal units.

5.0 EVALUATION OF CONDITION

Construction of the SDU 3A/3B and 5A/5B disposal cells began in February 2011. Project construction efforts concluded June 2013. During the project construction efforts, Closure and Waste Disposal Authority (C&WDA) implemented the UWMQ process. As it applies to construction of new SDUs, the process provides a structured approach to document and assess activities or conditions during construction that could impact assumptions in the PA. The UWMQ procedure was implemented in April 2012. Activities or conditions documented prior to this date are screened and evaluated in this document. Activities or conditions that occurred after that date are included in this UWMQE if the activity screened positive (i.e., required further evaluation by C&WDA).

As they relate to the as-built configurations of SDUs 3 and 5, the following relevant conditions warrant evaluation:

5.1 Materials of Construction

The SDF PA relies on the concrete roof, walls, and floor structures as both a physical and chemical barrier for migration of water and contaminants through the system. Thus, any activities or conditions that affect the quality of these structures must be evaluated to ensure that it meets the assumptions of materials performance. Table 5.1-1 contains the properties of cementitious materials used in SDUs that are important to the SDF PA and may be used throughout the evaluation of materials of construction. [SRR-CWDA-2009-00017]

Table 5.1-1: Cementitious Materials Properties for SDUs

Material	Porosity (%)	Dry Bulk Density (g/cm^3)	Particle Density ρ_p (g/cm^3)	Hydraulic Conductivity $k_{h,v}$ (cm/s)	Effective Diffusion Coefficient D_e (cm^2/s)
Low quality concrete – lower mud mat	21.1	2.06	2.61	1.0E-08	8.0E-07
High quality concrete – walls, roof, floor, upper mud mat	11.0	2.22	2.49	9.3E-11	5.0E-08
Saltstone and clean grout cap	58.0	1.01	2.40	2.0E-09	1.0E-07

[SRR-CWDA-2009-00017]

The following conditions related to the concrete design specification were documented during construction and have the potential to impact the concrete components of the unit(s):

1. Concrete slump was outside of specification
2. Concrete air content was out of specification – high
3. Concrete air content was out of specification - low

5.1.1 Concrete Slump Outside of Specification Due to Admixture (SDDR 11269 and SDDR 11305)

Description of Event or Condition

SDDRs 11269 and 11305 describe concrete slumps that exceed the maximum slump specified for the Type V (Class III sulfate resistant) concrete in C-SPP-Z-007, Rev 1 for mix design D5000-8-S-2-AB. Each event was evaluated for water to cement ratio and found to be within specification. The design mix contains a low water to pre-mix ratio and admixture HRWR ADVA380 was added to ensure workability.

Evaluation of Impacts

The concrete described in SDDRs 11269 and 11305 is within the parameters of the design mix for both cementitious constituents as well as water. In addition, cylinder breaks of this batch indicated that the concrete developed strength as expected. Since the admixture was added for workability, and does not impact concrete properties that affect PA dose results, the conditions described within SDDRs 11269 and 11305 do not adversely impact the PA.

5.1.2 Concrete Slump Outside of Specification Due to Higher Than Expected Moisture Content in Aggregate (SDDR 11539)

Description of Event or Condition

SDDR 11539 describe a single batch concrete slump that exceed the maximum slump specified for the Type V concrete in C-SPP-Z-007, Rev. 1 for mix design D5000-8-S-2-AB at the midpoint of batch placement. Upon discovery of this condition, the remainder of the batch was rejected and placement of the batch was stopped. The design mix contains a low water to pre-mix ratio and admixture HRWR ADVA380 was added to ensure workability. The concrete vendor reviewed the materials inputs and found that the ARGOS 67 aggregate component contained slightly higher moisture content than originally believed, attributing an additional 7.2 gallons of water to the batch. The "held back water" available for addition at the job site was 31.8 and was not used during the placement. The high slump is attributable to the HRWR ADVA380 super plasticizer added for workability.

Evaluation of Impacts

The total water added to the batch, both at the concrete plant, and from moisture in the concrete components resulted in a water to pre-mix ratio of 0.347, which is below the maximum water to pre-mix ratio of 0.38 in C-SPP-Z-007, Rev 1 for mix design D5000-8-S-2-AB. Since the water to pre-mix is within limits of the specification and the admixture does not impact concrete properties that affect PA dose results, the conditions described within SDDR 11539 does not adversely impact the PA.

5.1.3 Concrete Air Content Outside of Specification – High (SDDR 11275)

Description of Event or Condition

SDDR 11275 describes the concrete air content of 6.5 % compared to the design specification of 3 % to 6 %. The concrete was deemed workable and was placed in wall panel casting bed B.

Evaluation of Impacts

Initial Properties

In general, increasing air entrainment increases the hydraulic conductivity. Thus, a slight increase in the air entrainment of the concrete may slightly increase the hydraulic conductivity of the concrete. The magnitude of the increase is expected to be small, localized, and would not impact the conclusions in the PA.

Degradation

Entrained air in concrete is an important feature of concrete related to the concretes ability to withstand the freeze – thaw cycle. Pore spaces are created when air bubbles are entrained in the concrete mix. Water that is present in the concrete will expand in the voids formed by the air bubbles during freezing. Since there is slightly higher air entrainment present in this batch it would slightly increase the ability of the concrete to accommodate ice formation during the freeze thaw cycle. Ultimately, all of the disposal structures are backfilled prior to operation so that the freeze-thaw cycle effects are greatly diminished for these units. Since

these units are ultimately backfilled and covered with a closure cap, increased degradation from the freeze thaw cycle is negligible and does not impact the conclusions in the PA.

5.1.4 Concrete Air Content Outside of Specification – Low (SDDR 11700)

Description of Event or Condition

SDDR 11700 describes the concrete air content of 2.5 % as tested during the middle of the placement compared to the design specification of 3 % to 6 %. The concrete was initially batched with an air content of 3.1 %.

Evaluation of Impacts

Initial Properties

In general, air entrainment in soils decreases the hydraulic conductivity of the soil. A slight decrease in the air entrainment of the concrete could theoretically decrease the hydraulic conductivity of the concrete, the magnitude of the change in air content and the quantity of material affected by this condition will have a negligible impact to the conclusions of performance in the PA.

Degradation

Entrained air in concrete is an important feature of concrete related to the concretes ability to withstand the freeze – thaw cycle. Pore spaces are created when air bubbles are entrained in the concrete mix. Water that is present in the concrete will expand in the voids formed by the air bubbles during freezing. Although there is slightly lower than expected air entrainment present in this batch, the disposal structures are backfilled prior to operation so that the freeze-thaw cycle effects are greatly diminished for these units. Since these units are ultimately backfilled and covered with a closure cap, increased degradation from the freeze thaw cycle is negligible and does not impact the conclusions of performance in the PA.

5.2 Critical Dimensions

The concrete components modeled in the PA can have a significant impact on the results. Therefore, minimum concrete thicknesses are key to SDU performance. In addition, the slope of the roof concrete impacts the infiltration of water into the SDU. The following condition documented during construction has the potential to impact performance of the unit(s):

5.2.1 Roof Slope Tolerance (2013-NCR-15-DZC-0001)

A sloped SDU roof is designed to shed water around the unit. The rate at which water sheds is a function of the roof slope, as well as other variables such as hydraulic conductivity of the concrete. The PA model assumed a 2 % slope to the SDU roof. ACI 117 construction tolerances for elevated concrete slabs allow tolerances on both the center and outer edge of the disposal unit such that the roof slope could be as low as 1.7 %. A recent SDF Special Analysis (SRR-CWDA-2013-00062) included sensitivity analysis of changes to roof slope at 1.5 %, 2.0 %, and 2.5 %. The evaluation assessed the change in flow into the disposal unit as a function of roof slope and determined, for the range of roof slope values that bound the construction tolerances, that the impact to water infiltration is negligible. The resulting release rates of key risk sensitive radionuclides (I-129, Tc-99) showed negligible increases

from the nominal 2% for the 1.5% case. Therefore, the Performance Objectives are not challenged by this condition.

5.3 Codes and Standards Compliance

National codes and standards are invoked to ensure that construction is performed in a reliable manner. Structures, Systems, and Components (SSCs) that are constructed in strict compliance with national codes and standards are understood to reliably perform as intended. If a SSC does not strictly comply with applicable codes and standards, additional evaluation is required to ascertain any impact to performance as modeled in the PA. The following conditions outside those specifically allowed by code were documented during construction and have the potential to impact performance of the unit(s):

1. Floor Slab Reinforcing Bar Installed with Less Clearance than Allowed by Code
2. Field Cured Cylinders Improperly Cured
3. Concrete Delivery Truck Exceeded Revolutions Required by Code

5.3.1 Floor Slab Reinforcing Bar Installation with Less Clearance than Allowed by Code (SDDR 11055 and SDDR 11102)

Description of Event or Condition

SDDRs 11055 and 11102 discuss reinforcing bar spacing in the perimeter footer of the floor slab. This area of the floor slab includes rebar to support the additional weight of wall panels, and rebar for both interior and exterior curbing. To accommodate the rebar needed some areas of the footer contain 0.25 inch spacing of rebar. ACI 117 Section 2.2.4 specifies that "*Distance between reinforcement shall not be less than the greater of the bar diameter or 1 in. for unbundled bars*." Distances less than required by ACI 117 could result in inadequate consolidation of concrete between reinforcement bars. Reinforcement bar for these units did not exceed 1 inch. Therefore, the minimum clearance required by ACI 117 is 1 inch.

Evaluation of Impacts

Crom Corporation evaluated the field conditions related to spacing of reinforcement bar. The evaluation resulted in compensatory actions to ensure proper consolidation of concrete, including concrete placement in multiple lifts with vibration of each lift, and the use of 0.75-inch vibrators to consolidate concrete in these congested areas.

Because appropriate compensatory actions were taken during the placement of concrete in these areas the concrete can be assumed to perform as modeled in the PA.

5.3.2 Field Cured Cylinders Improperly Cured (SDDR 11511)

Description of Event or Condition

Curing of concrete samples is required to ensure that testing of samples is representative of the concrete that was placed. Concrete for SDU 3A cell was placed during a period where temperatures dropped below freezing the night after the placement. Concrete average concrete temperature at the time of placement was 60° F. Test cylinders were generated, removed from the roof placement, placed at ground level, and covered. Ambient

temperatures after placement dropped below 32° F for approximately 8 hours, with the low of 24° F. The roof concrete was cured with a fog mist. Freezing of the roof concrete was not observed after placement. Field cured cylinders exhibited evidence of freezing and associated low compressive strength.

Evaluation of Impacts

Crom Corporation evaluated the roof placement details and concluded that the cylinders were improperly cured, and are not representative of the roof placement. In addition, Crom evaluated the weather conditions of the concrete placement and concluded that conditions did not meet the ACI requirements for cold weather concreting. The Crom evaluation indicated that the mass of the placement and insulation from plywood underneath the placement should have generated curing temperatures above ambient. Thus, although the cold temperatures are expected to slow strength attainment, the concrete itself is not damaged.

Due to the relatively small size of the cylinders themselves, freeze damage to the cylinder concrete is more likely than freeze damage to the large concrete placement. In addition, visual indications of freeze damage were apparent on the cylinders, but not observed on the roof placement. Therefore, the frozen concrete cylinders are likely to not be representative of the concrete placement. The concrete placement is assumed to be within specification and does not adversely affect the conclusions in the PA.

5.3.3 Concrete Delivery Truck Exceeded Revolutions Required by Code (SDDR's 11272, 11307, and 11339)

Description of Event or Condition

ACI 301 limits drum revolutions on the delivery truck to 300. SDDRs 11272, 11307 and 11339 describe concrete placed after 300 revolutions were recorded on the drum revolution counter. In two cases (11272 and 11307) the counter was not reset prior to leaving the batch plant. For these cases the recorded counts were 303 and 354, but since the starting count was not recorded, the actual revolutions is indeterminate.

For case 11339 the revolution counter correctly indicated 311 revolutions at the conclusion of the placement, which exceeds 300 revolutions allowed.

Evaluation of Impacts

In cases 11272 and 11307 the driver failed to reset the counter, thus the actual revolutions is indeterminate. However, the concrete exhibited adequate workability, additional water was not added after 300 revolutions was reached, and compressive strength data representative of the batch indicated that the concrete reached adequate strength. Thus, it was concluded that the concrete was not affected by exceeding the 300-revolution limit and will not adversely impact the conclusions of the PA.

For case 11339 a total of 25 gallons of water of 31 gallons available was added and the drum rotated a total of 60 times to increase workability. The truck left the job indicating a total of 311 revolutions. Compressive strength data representative of the batch indicated that the concrete reached adequate strength. Thus, it was concluded that the concrete was not affected by exceeding the 300-revolution limit and will not adversely impact the conclusions of the PA.

5.4 Inadvertent Events

The following inadvertent event occurred during construction.

5.4.1 Concrete Consolidation Vibrator Wedged in Reinforcing Bar during Concrete Placement (SDDR 11393)

Description of Event or Condition

During concrete placement on SDU 5A cell column #37, a vibrator used to consolidate concrete during the placement became wedged between the reinforcing bar and could not be removed. After the sono tube was removed, the leading surface of the vibrator (approximately 2 inches in diameter) was observed approximately 8 feet – 8 inches from the cell roof. The vibrator is approximately 1 foot in length and is attached to a steel cable. The cable was cut and became encased in subsequent concrete placements. The vibrator visible at the surface of the column was removed to a minimum of 0.25 inch beneath the column surface and the column repaired with CP-MP83 epoxy.

Evaluation of Impacts

CP-MP83 is an epoxy approved for repair of minor surface imperfections. The location of the anomaly is interior to the cell itself. PA sensitivity case C models the columns with initial properties of Type V (Class III sulfate resistant) cement but through non-mechanistic means, degrades the concrete to less than the surrounding saltstone. In the SA, the columns are modeled with saltstone properties but degrade vertically in two-foot segments, causing the column to degrade much more rapidly than the surrounding saltstone. Since the columns are degraded faster than the saltstone in the model, the model treats the columns as a "fast flow path" during the performance period. This approach bounds any negative impacts resulting from the presence of the vibrator or attached steel cable.

6.0 CONCLUSION

The as constructed state of SDU 3A/3B, 5A/5B described in this document is consistent with the conclusions of the *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site*, SRR-CWDA-2009-00017. The distinct as-built conditions identified in Table 3.0-1 were evaluated against inputs used in the SDF PA model. None of these conditions were found to impact the conclusions of the PA. One condition, related to roof slope, was modeled separately and shown to have negligible impact to the conclusions of the SDF PA and therefore the CA (SRNL-STI-2009-00512), and the salt WD Basis Document (DOE-WD-2005-001).

7.0 REFERENCES

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SDDR 11275, *Casting Bed 2 Panel B*, Supplier ID # Z-109, Savannah River Site, Aiken, SC, September 15, 2011.

SDDR 11305, *Casting Bed Panel 14E*, Supplier ID # Z-110, Savannah River Site, Aiken, SC, September 28, 2011.

SDDR 11307, *Truck #6780772, Delivery Ticket #37715203 had 97 Revolutions Indicated on the Counter at the 5:00 AM Arrival*, Supplier ID # Z-111, Savannah River Site, Aiken, SC, September 28, 2011.

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