Z-Area Vault 4
Phase 1 Soil Sample Analytical Data Report

ERD-EN-2008-0056

Revision 0

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EXECUTIVE SUMMARY

Soil and gravel samples at various depths were collected from four locations adjacent to Vault 4, and from one background location. The samples were analyzed for numerous chemical and radiological constituents. The locations adjacent to Vault 4 were selected below active Vault 4 wet spots. The Vault 4 locations were selected and sampled to determine if transfer of contamination from the wet spot to the soil occurred in the immediate vicinity of the wall and to predict the potential impact to the local groundwater.

The sample results indicate that most contamination appears to be restricted to the soil (gravel) surface in the immediate vicinity of the Vault 4 wall. For the constituent with the highest activity, cesium-137 (Cs-137), the radioactive concentration in the deepest interval sampled is less than 1% of its surface concentration.

Additional sampling is recommended from the two most contaminated locations to better define the depth of contamination, the areal extent of contamination, and concentrations of contaminants. Since many constituents were detected at levels which do not cause concern either for human health or for contaminant migration, the constituent list can be reduced. Additional sampling and analysis for iodine -129 (I-129) is also recommended, including an analysis method that includes a chemical separation of iodine from cesium in order to remove interference by Cs-137.

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1.0 PURPOSE

The objective of this document is to report analytical data results of soil samples collected beneath wet spots on the exterior wall of the Saltstone Disposal Facility Vault 4.

2.0 SAMPLING APPROACH

Soil and gravel samples were collected per the Vault 4 Soil Sample Collection Plan (Liner 2008) from four locations adjacent to the vault and from one background sample (Figure 1). The four vault locations were selected to test active wet spots at Vault 4 Cells E, F, J, and L; they are named ZV4-002 through -005. ZV4-001 is the background sample. At each location, three samples were collected (Figure 2). Two samples were collected from the gravel immediately against the vault wall, representing depth intervals of 0 to 3 inches, and 3 to 12 inches. These samples are intended to catch possible contamination that might reside on or near the surface. A third sample was collected from soil two or three feet away from the vault wall, in the dirt backfill beyond the edge of the vault footer, at a nominal depth interval of 12 to 24 inches. This soil sample is intended to catch any contamination that might have washed down through the gravel and out past the edge of the footer. Samples were collected between January 31 and February 4, 2008.

Samples were analyzed for 23 metals, 9 organic compounds, 6 inorganic anions, and 18 radiological analytes (Liner 2008). Samples were analyzed at GEL in Charleston, SC. Two samples with the highest gross alpha results were later speciated for 15 additional alpha-emitting radionuclides.

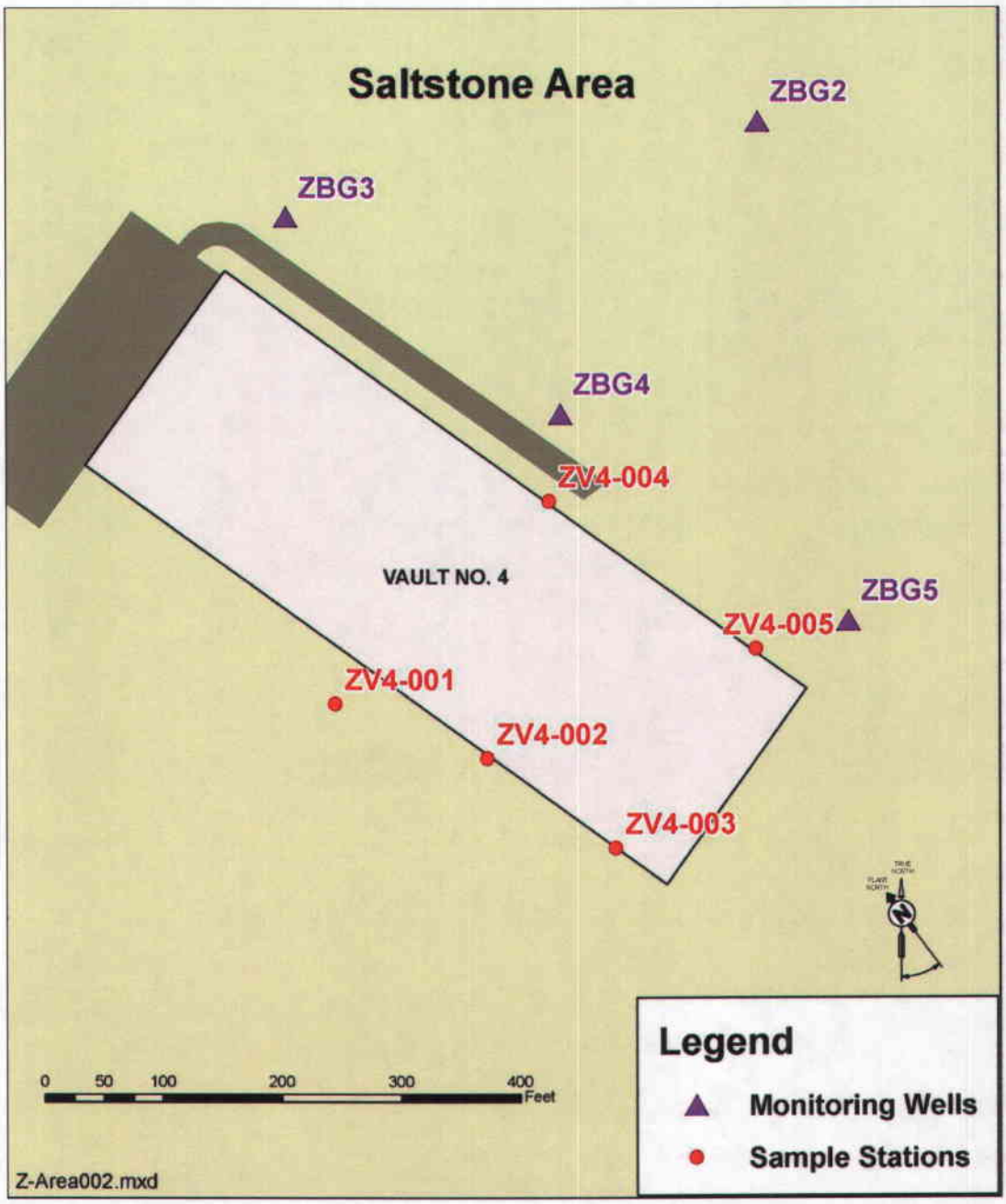
3.0 RESULTS

Analytical results for important potential radionuclides and nitrate are shown in Table 1, and relevant points regarding the data are listed here.

- The ground surface adjacent to all four cells is contaminated with fission products.

- The ground surface next to cells E and F is contaminated to a greater degree than cells J and L. The 0- to 3-inch depth interval samples at locations ZV4-002 (Cell E) and ZV4-003 (Cell F) each show about 200,000 pCi/g nonvolatile beta, mostly cesium-137 (Cs-137). The surface intervals at cells J and L (stations ZV4-004 and -005) are less contaminated, and show 210 and 100 pCi/g nonvolatile beta.

- Over 99% of the detected radiological contamination is attributable to cesium-137. Antimony-125 is the next most abundant radionuclide. Strontium-90, technetium-99, tritium, iodine-129, plutonium-238, and thorium and uranium isotopes were also detected.



Projection: Universal Transverse Mercator
Datum: North American Datum 1927
Zone: 17

To place on the North American Datum 1983, move the projection line 13 meters south and 15 meters west.

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Figure 1. Saltstone Area

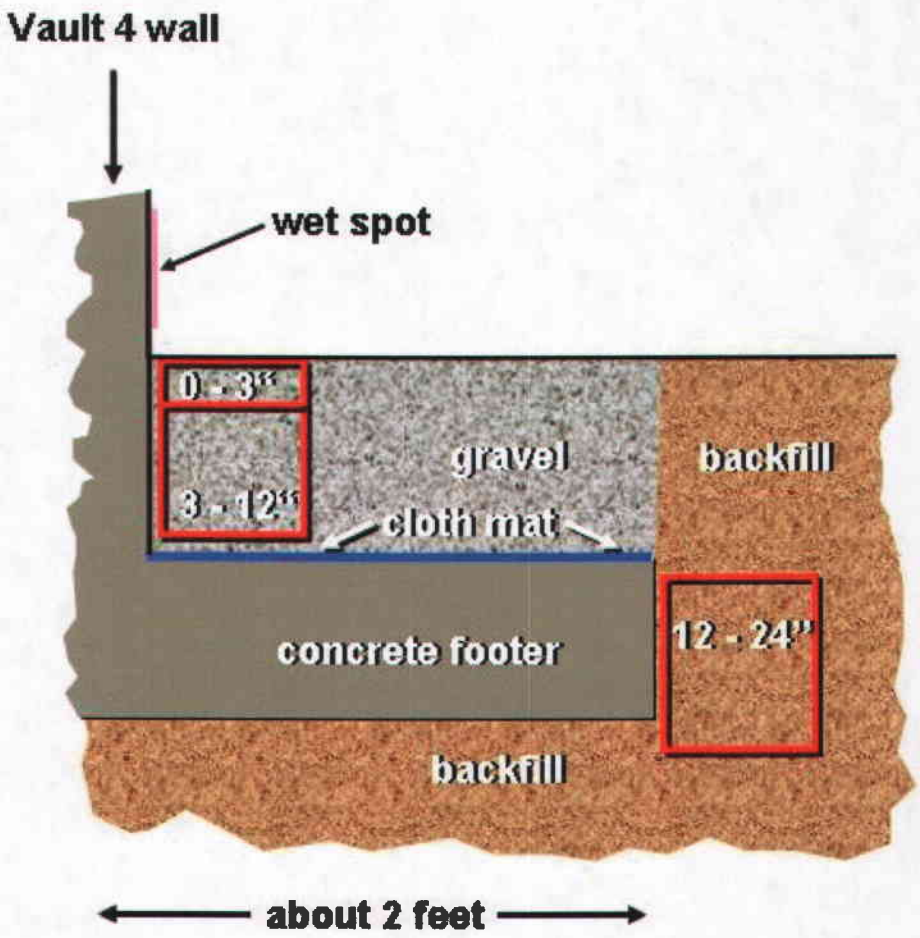

Figure 2. Vault 4 Wall

Table 1. Analytical Results for Saltstone Phase 1 Sampling

Location	Station	Sample ID	Depth	G ALPHA	NV BETA	CS-137	SB-125	SR-90	TC-99	H-3	I-129	Nitrate
Background	ZV4-001	ZV4SS-0000002	gravel 0-3	30	38	0	ND	ND	ND	ND	ND	1.5
Background	ZV4-001	ZV4SS-0000003	gravel 3-12	38	52	0	ND	ND	ND	ND	ND	0.5
Background	ZV4-001	ZV4SS-0000001	soil 12-24	8	9	ND	ND	ND	ND	ND	ND	0.9
Cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	1930	183000	209000	190	38	67	ND	ND	77
Cell E	ZV4-002	ZV4SS-0000006	gravel 3-12	107	9680	11700	55	ND	ND	18	R	66
Cell E	ZV4-002	ZV4SS-0000004	soil 12-24	12	42	53	4	ND	ND	ND	R	140
Cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	1860	187000	171000	511	48	79	R	ND	ND
Cell F	ZV4-003	ZV4SS-0000010	gravel 3-12	ND	123000	117000	231	ND	ND	11	2.7	ND
Cell F	ZV4-003	ZV4SS-0000008	soil 12-24	16	613	850	86	ND	ND	19	R	324
Cell J	ZV4-004	ZV4SS-0000012	gravel 0-3	10	210	401	67	ND	ND	ND	R	1.9
Cell J	ZV4-004	ZV4SS-0000013	gravel 3-12	17	181	153	10	ND	ND	ND	R	2.4
Cell J	ZV4-004	ZV4SS-0000011	soil 12-24	7	ND	0	ND	ND	ND	ND	ND	ND
Cell L	ZV4-005	ZV4SS-0000016	gravel 0-3	20	100	229	9	ND	ND	ND	R	0.3
Cell L	ZV4-005	ZV4SS-0000017	gravel 3-12	16	52	23	1	ND	ND	ND	ND	ND
Cell L	ZV4-005	ZV4SS-0000015	soil 12-24	13	ND	ND	ND	ND	ND	ND	ND	ND

Not detected in any sample: carbon-14, cobalt-60, nickel-59, nickel-63, niobium-94, ruthenium-106.
Results given in pCi/g (rads) and mg/kg (nitrate/nitrite as nitrogen)
ND = not detected; R = result rejected

Carbon-14, cobalt-60, nickel-59, nickel-63, niobium-94, and ruthenium-106 were not detected in any sample.

- Naturally occurring potassium-40, thorium isotopes, actinium-228, lead-212, lead-214, and thallium-208 were detected at levels expected for granitic gravel and soil.

- Uranium-234, -235, and -238 were detected in the two most contaminated samples at concentrations slightly higher than normal background. Uranium is naturally occurring in granite and in SRS soil, but the isotopic ratios of the sample at ZV4-003 are consistent with enriched uranium, indicating that the uranium represents contamination.

Based on the four sample locations available, most contamination appears to be restricted to the immediate vicinity of the wall. For example, in the most contaminated location, ZV4-002 (cell E), there are 209,000 pCi/g cesium-137 in the uppermost three inches of gravel. In the 3 to 12-inch depth interval, the concentration drops 94% to 11,700 pCi/g. In the 12 to 24 inch depth interval, 1.5 to 2 feet away from the Vault wall, the Cs-137 concentration drops a further 99%, to 53 pCi/g. In all four contaminated sample locations, the Cs-137 concentration in the 12 to 24 inch depth interval is less than 1% of its surface concentration. Although Cs-137 is the most dramatic example, other nuclide concentrations also decrease away from the building.

The two most contaminated samples were the 0-3 inch depth intervals for cells E and F (ZV4-002 and -003). The gross alpha results for these two samples were each about 1900 pCi/g. Hence, these samples were subsequently analyzed for specific alpha-emitting radionuclides (Table 2), but the summed activity of all specific analytes is below 10 pCi/g for both samples – the gross alpha results are inconsistent with the alpha speciation results. Since gross alpha is only a screening method, results for the specific radionuclides are accepted in preference to the gross alpha results.

4.0 DISCUSSION

To assess whether constituents detected in samples adjacent to the vault are potentially related to the salt placed in the vault, the analytical results for sample locations ZV4-002 through -005 were compared to results for the background location, ZV4-001.

If the maximum sample concentration for an analyte exceeds twice the average background concentration for the 0 to 12 inch depth interval, then the analyte is potentially salt-related.

This background comparison identifies 11 inorganics, 4 volatiles, and 9 radionuclides as contaminants of potential concern, including: antimony, arsenic, barium, boron, iron, lead, mercury, nitrate, silver, strontium, thallium, benzene, butyl alcohol, isobutanol, toluene, antimony-125, cesium-137, strontium-90, technetium-99, thorium-230, uranium-233/234, uranium-235, uranium-238, and plutonium-238.

Table 2. Alpha Speciation of Selected Saltstone Phase 1 Samples

Location	Station	Lab Sample ID	Depth	Analyte	Result
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Am-241	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Am-243	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Cm-242	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Cm-243/244	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Cm-245/246	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Np-237	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Pu-238	1.5
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Pu-239/240	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Pu-242	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Ra-226	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Th-228	1.4
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Th-230	1.0
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	Th-232	0.8
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	U-233/234	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	U-235	ND
cell E	ZV4-002	ZV4SS-0000005	gravel 0-3	U-238	0.4
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Am-241	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Am-243	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Cm-242	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Cm-243/244	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Cm-245/246	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Np-237	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Pu-238	1.2
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Pu-239/240	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Pu-242	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Ra-226	R
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Th-228	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Th-230	1.6
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	Th-232	ND
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	U-233/234	3.6
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	U-235	0.6
cell F	ZV4-003	ZV4SS-0000009	gravel 0-3	U-238	1.8

Results in pCi/g
ND = Not Detected;
R = Result Rejected

5.0 CONCLUSIONS / RECOMMENDATIONS

In order to more accurately predict the impact of soil contamination at Z-Area Vault 4 on groundwater quality and health risk to industrial workers, it is recommended to collect additional samples.

Phase 2 sampling should be directed to better define the depth of contamination, the areal extent of contamination, and concentrations of contaminants. Since many constituents were detected at levels which do not cause concern either for human health or for contaminant migration, the constituent list may be reduced. Recommendations are:

- Conduct step-out sampling along the wall on both sides of each of the two most contaminated locations (ZV4-002 and -003), and several feet out beyond the building footer at both locations.

- At each step-out sample beyond the footer, depth intervals should include two intervals deeper than 24 inches.

- Recommended analytes are gross alpha, nonvolatile beta, Cs-137, Sr-90, Sb-125, Tc-99, tritium, I-129, Pu-238, U-233/234, U-235, U-238, and nitrate/nitrite as nitrogen.

- Resample the Phase 1 location at ZV4-002, and analyze for I-129 only.

- I-129 should be analyzed by a method that includes a chemical separation of iodine from cesium in order to remove interference by Cs-137.

6.0 REFERENCES

Liner, K., 2008. *Z-Area Industrial Solid Waste Landfill Disposal Facility Vault 4 Soil Sample Collection Plan*, SRS-REG-2008-00007, Revision 0, 1/29/08

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WSRC, 2007. *Saltstone Production and Disposal Facility Website Data – Third Quarter 2007*, SRS-REG-2007-00033, November 6, 2007